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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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Home Power

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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Contents

Access

Home Power Magazine
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Think About It

"There can be hope only for a society which acts as one big family, and not as many seperate ones."

Anwar al-Sadat. 1918-1981.

Cover

Solar Power at work. The two home-made solar cookers make dinner. The 12-module Kyocera PV array makes about 600 Watts of electricity.

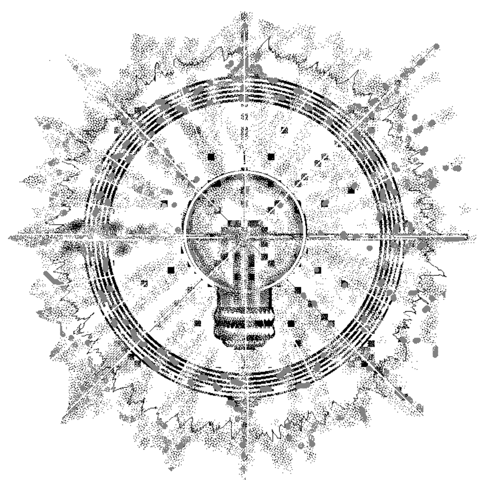
Photo by Bob-O Schultze & Richard Perez.

And the Results Are In

Thanks
Many thanks to all of you who took the time to fill out the reader survey. Much appreciated!

The Results
A total of 283 readers let us know how they feel. The most common concern was that Home Power would go glossy and lose its hands on approach. This is NOT going to happen. We hope that this issue will help put those fears to rest. The yes votes for more pages totaled 70.3%, yes for recycled paper was 71.0%, going to color got the lowest percentage at 39.5%. The number of bucks averaged out at $14.53 with a range from zero to $60.00.

What We Decided
After much head pounding, hair pulling and kitty petting a decision has been reached. Yes to more pages. Issue 21 will have more pages. Recycled paper will, unfortunately, have to wait six to eight months. The paper we are currently using, 35# Columbia Web, is not available in post consumer paper. That means we would have to go to heavier 40# book stock, which has only 40% post consumer paper. The 40# book is bleached (nasty dioxin producing chemicals) and would greatly increase postage. At this time it would take 4 months just to get this paper and it would increase production costs by approximately 45% (paper & postage). Four post consumer recycled paper mills are due to go on line within 6 to 8 months. One company is working on post consumer 35# Columbia Web. This should help to increase the supply and reduce the cost.



We will stay with color, but only on the non-clay coated cover. The reason for this is newsstands. Four of the five distributors now carrying HP asked for more #19's and increased their standing orders. We want to spread the word but we have to get folks to pick it up.

We will continue to use soybean based inks throughout HP. Black soybean inks are non-toxic, color soybean inks do contain 6-10% toxic materials.

The Bottom Line
Here's where the rubber meets the road, as of #21 HP's new subscription rate will go from $6.00 per year to $10.00. Here are the reasons: 1) more pages, 2) the U.S. Postal Service will be raising their rates sometime early in 1991, and 3) we will be saving part of the $10 for recycled paper.

The Why
You might ask why we are concerned with magazine distributors and newsstands. If you have seen or heard any of the many recent programs on renewables you might have noticed that they ALL say that renewable energy is the energy of the future. Not true, it's the energy of TODAY. Our goal is to help people prove that they are not helpless. We can make a difference right now, no matter how small. Many small savings can add up to big solutions! For instance, if folks only knew what to do disposable batteries could become a thing of the past. This might sound like a small thing until you think about our planets resources, land fills, and the toxic materials in batteries. Or if everyone in the U.S. went to energy efficient lighting 30 to 50 power planets could be eliminated.

We need this information. Our planet needs this information. Our children need to do things differently if they are to survive. We hope that Home Power Magazine contributes to a saner and safer future.

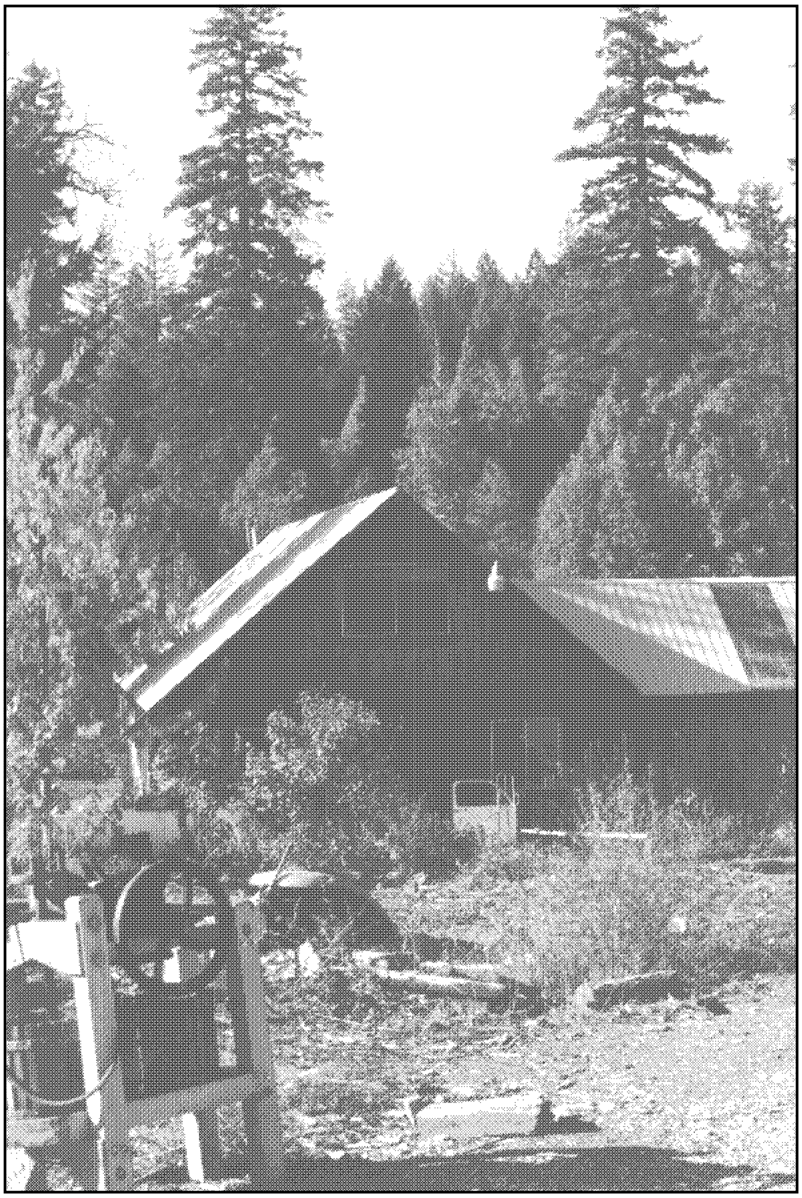
So here it is. We hope everyone understands.

Karen Perez

KENNEDY CREEK HYDROELECTRIC SYSTEMS

Richard Perez

In the 6,000 foot tall Marble Mountains of Northern California, it rains. Wet air flows straight from the Pacific Ocean only forty airline miles away. This moist ocean air collides with the tall mountains and produces over sixty inches of rainfall annually. Add this rainfall with the spectacular vertical terrain and you have the perfect setting for hydroelectric power. This is the story of just one creek in hydro country and of five different hydro systems sharing the same waters.



Above: Gene Strouss's hydroelectric home. They make all their own power and grow most of their food. Their hydro has made over 40 kWh daily for the last nine years and at an overall cost of about 3¢ per kWh. of electric power. Photo by Richard Perez.

Kennedy Creek

Kennedy Creek is on the west drainage of 4,800 foot tall Ten Bear Mountain. The head waters of Kennedy Creek are located in a marsh at 2,500 feet of elevation. The headwaters are spread out over a 10 acre area and the power of Kennedy Creek doesn't become apparent until its waters leave the marsh. After a winding course over five miles in length, Kennedy Creek finally empties its water into the Klamath River at about 500 feet elevation. This gives Kennedy Creek a total head of 2,000 vertical feet over its five mile run.

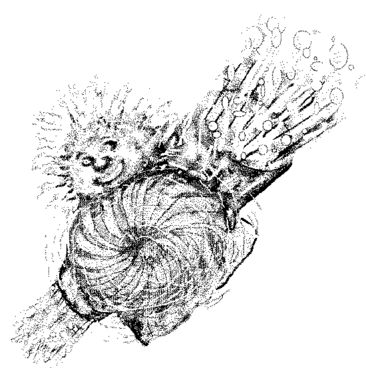
The volume of water in Kennedy Creek is not very great. While we weren't able to get really hard data as to the amount of water, the residents guessed about 500 gallons per minute. Kennedy Creek is not large by any standards. It varies from two to eight feet wide and from several inches to about four feet deep. We were able to cross it everywhere and not get our feet wet. The point here is that you don't need all that much water if you have plenty of vertical fall.

The Kennedy Creek Hydro Systems

Kennedy Creek supports five small scale hydroelectric systems. Each system supplies electric power for a single household. Each system uses the water and returns it to the creek for use by the next family downstream.

These systems are not new comers to the neighborhood; they have been in operation for an average of 7.6 years. These systems produce from 2.3 to 52 kilowatt-hours of electric power daily. Average power production is 22 kWh daily at an average installed cost of $4,369. If all the hydroelectric power produced by all five Kennedy Creek systems is totaled since they were installed, then they have produced over 305 megawatt-hours of power. And if all the costs involved for all five systems are totaled, then the total cost for all five systems is $21,845. This amounts to an average of 7¢ per kilowatt-hour. And that's cheaper than the local utility. One system, Gene Strouss's, makes power for 3¢ a kilowatt-hour, less than half what's charged by the local utility.

All the power production data about the Kennedy Creek hydroelectric systems is summarized in the table on page 7. All cost data is what the owners actually spent on their systems. Being country folks, they are adept at shopping around and using recycled materials. The cost figures do not include the hundreds of hours of labor that these hydromaniacs have put into their systems.



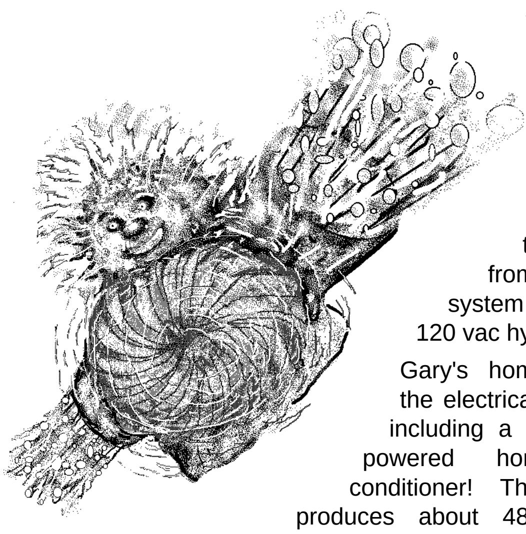
Let's take a tour of the Kennedy Creek Hydros starting at the top of the creek and following its waters downward to the Klamath River.

Gary Strouss

Gary Strouss wasn't home the day that Bob-O, Stan Strouss, and I visited Gary's hydroelectric site. Gary is a contractor and off about his business. So as a result, we got this info from his brother Stan and father, Gene (the next two systems down Kennedy Creek).

Gary's hydroelectric system uses 5,300 feet of four inch diameter PVC pipe to deliver Kennedy Creek's water to his turbines. The head in Gary's system is 280 feet. In hydro lingo, head is the number of VERTICAL feet of drop in the system. Static pressure is 125 psi at the turbines.

Gary uses two different hydroelectric generators. One makes 120 vac at 60 Hz. directly and the other produces 12 VDC. The 120 vac system is very similar to the one his father, Gene Strouss uses and is described in detail below. Gary's 120 vac system produces 3,00 watts about eight months of the year. During the summer dry periods, Gary switches to the smaller 12 Volt hydro.



The 12 VDC system uses a Harris turbine that makes about 10 Amperes of current. The Harris turbine is fed from the same pipe system as the larger 120 vac hydro.

Gary's home contains all the electrical conveniences, including a rarity in an AE powered home- an air conditioner! The 120 vac hydro produces about 48 kilowatt-hours daily, so Gary has enough power for electric hot water and space heating.

Stan Strouss

Stan's hydro is supplied by 1,200 feet of 2 inch diameter PVC pipe. His system has 180 feet of head. In Stan Strouss's system this head translates to 80 psi of static pressure, and into 74 psi of dynamic pressure into a 7/16 inch diameter nozzle.

Stan uses a 24 Volt DC Harris hydroelectric system producing three to ten Amperes. Stan's hydro produces an average of 180 Watts of power. This amounts to 5,400 Watt-hours daily. The system uses no voltage regulation.

The DC power produced by the hydro is stored in a 400 Ampere-hour (at 24 VDC) C&D lead-acid battery. These ancient cells were purchased as phone company pull-outs eight years ago. Stan plans to use an inverter to run his entire house on 120 vac. Currently. he uses 24 VDC for incandescent lighting. When I visited, there was a dead SCR type inverter mounted on the wall and Stan was awaiting delivery of his new Trace 2524.

Stan's system is now eight years old. The only maintenance he reports is replacing the brushes and bearing in his alternator every 18 months. That and fixing his water intake filters wrecked by bears.

Above: Gene Strouss (on the left), and his son Stan, stand before Gene's hydro. This hydro makes 120 vac at 60 cycles. Gene's system uses no batteries and no inverter. He consumes the power directly from the hydro. Photo by Richard Perez.

KENNEDY CREEK HYDROS

Hydroelectric System's Operator	*System's Age in Years*	*Average Power Output in Watts*	*Daily Power Output in kWh.*	*Total Power made in kWh.*	*System Cost*	*System Power cost to date $ per kWh.*
Gary Strouss	6	2,040	49	107,222	$8,795	$0.08
Stan Strouss	8	180	4	12,614	$3,520	$0.28
Gene Strouss	9	2,166	52	170,767	$5,950	$0.03
Max&Nena Creasy	6	97	2	5,098	$1,295	$0.25
Jody&Liz Pullen	9	120	3	9,461	$2,285	$0.24
AVERAGES	7.6	921	22	61,033	$4,369	$0.18
TOTALS	38	4,603	110	305,163	$21,845	

Kennedy Creek as a Power Producer
Total All Systems Cost / Total Power All Systems Made to Date
in Dollars per kiloWatt-hour ($ / kWh.) $0.07

Stan and his father, Gene, own and operate a sawmill and lumber business from their homesteads. This business, along with raising much of their own food, gives the Strouss families self-sufficiency.

Gene Strouss

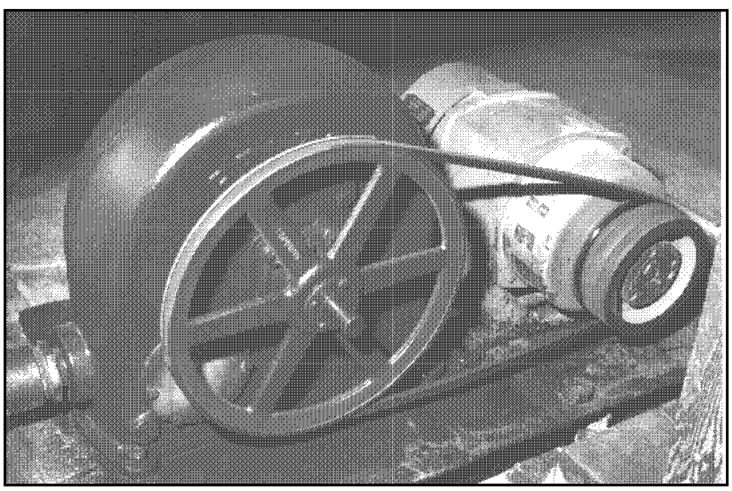
Gene Strouss's hydroelectric system is sourced by 600 feet of six inch diameter steel pipe connected to 1,000 feet of four inch diameter PVC pipe. Gene got an incredible deal on the 20 foot lengths of steel pipe, only $5 a length.

A twelve inch diameter horizontal cast steel Pelton wheel translates the kinetic energy of moving water into mechanical energy. The Pelton wheel is belted up from one to three and drives an 1,800 rpm, 120 vac, 60 Hz. ac alternator. All power is produced as 60 cycle sinusoidal 120 vac. The Pelton's mainshaft runs at a rotational speed of between 600 and 800 rpm. The output of the alternator is between 1,500 to 2,500 watts out depending on nozzle diameter. At an annual average wattage of 2,000 watts, Gene's turbine produces 48,000 watt-hours daily.

The pipe delivers 60 psi dynamic pressure into a 9/16 inch in diameter nozzle, for summertime production of 1500 watts at 70 gallons per minute of water through the turbine. In wintertime with higher water levels in Kennedy Creek, Gene switches the turbine to a larger,13/16 inch diameter nozzle. Using the larger nozzle reduces the dynamic pressure of the system to 56 psi and produces 2,500 watts while consuming 90 gallons per minute.

Gene's system is nine years old. The only maintenance is bearing replacement in the alternator every two years. Gene's system uses no batteries, all power is consumed directly from the hydro. Gene keeps a spare alternator ready, so downtime is minimal when it is time to rebuild the alternator. Regulation is via a custom made 120 vac shunt type regulator using a single lightbulb and many parallel connected resistors. Major system appliances are a large deep freezer, a washing machine, 120 vac incandescent lighting, and a television set.

Gene's homestead is just about self-sufficient (which is why he needs his freezer). Hundreds of Pitt River Rainbow trout flourish in a large pond created by the Pelton wheel's tail water. The trout love the highly aerated tail water from the hydro turbine. Gene grew 100 pounds of red beans for this winter and maintains two large greenhouses for winter time vegetables. Gene Strouss also keeps a large apple orchard. Gene raises chickens and this, with the trout, make up the major protein portion of his diet. His major problem this year was bears raiding the apple orchard and destroying about half of the 250 trees. For a second course, the bears then ate up over sixty chickens, several turkeys, and a hive of honey bees. Gene called his homestead, "My food for wildlife project."



Above: Gene Strouss's hydro plant. The Pelton wheel is on the left and belted up to the 120 vac alternator on the right.
Photo by Richard Perez.

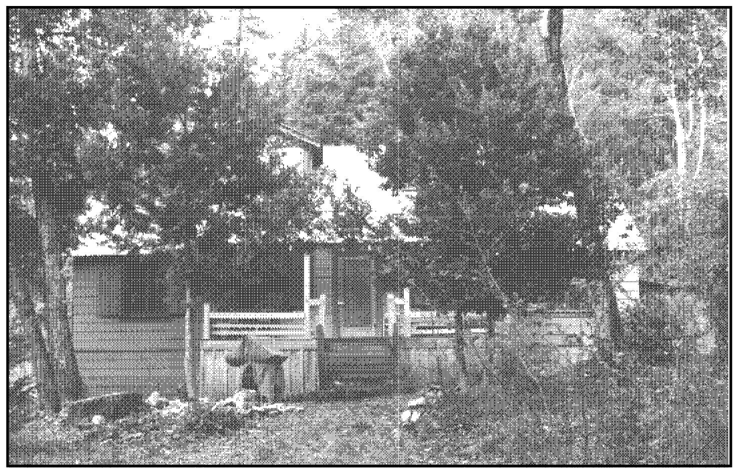
Max and Nena Creasy

Seven hundred feet of two inch diameter PVC pipe sources a Harris hydro turbine with two input nozzles. Static pressure at the turbine is about 80 psi from a vertical head of 175 feet. It produces five to eight Amperes depending on the availability of water. Max and Nena use 100 feet of #2 USE aluminium cable to feed the hydro power to the batteries.

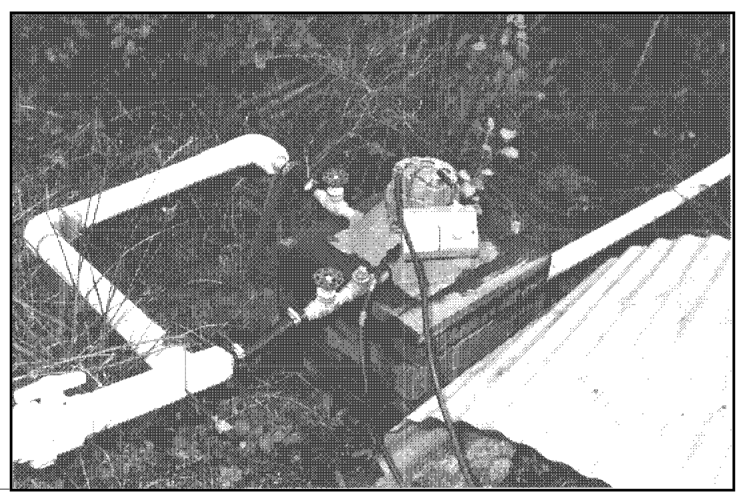
Max and Nena's system uses two Trojan L-16 lead-acid batteries for 350 Ampere-hours of storage at 12 VDC. All usage is 12 Volts directly from the battery. Max and Nena don't use an inverter. The system uses no voltage regulation and overcharging the batteries has been a problem. Power production is 97 Watts or 2,328 Watt-hours daily.

The major appliances used in this system are halogen 12 VDC incandescent lighting, television, tape deck and amplifier. This system has been operation for the last six years. Nena reports two year intervals between bearing and brush replacement in their alternator.

Max works with the US Forest Service and Nena runs a cottage industry making and selling the finest chocolate truffles I have ever eaten.



Above: Max and Nena Creasy's hydroelectric home.
Below: Max & Nena's Harris hydro turbine recharges their 12 Volt system at about six Amps (24 hours a day).
Photo by Richard Perez.



Jody and Liz Pullen

Jody and Liz's hydro system uses 1,200 feet of 2 inch diameter PVC pipe to bring the water to the turbine. Jody wasn't sure of the exact head in the system and without a pressure gauge it was impossible to estimate. The system works, producing more power than Jody and Liz need, so they have never investigated the details.

The turbine is a Harris 12 Volt unit. Jody normally sets the Harris current output at six to ten Amps so as not to overcharge his batteries. An average output figure for this system is about 120 Watts or 2,800 Watt-hours daily. The power is carried from the hydro to the batteries by 480 feet of 00 aluminium USE cable.

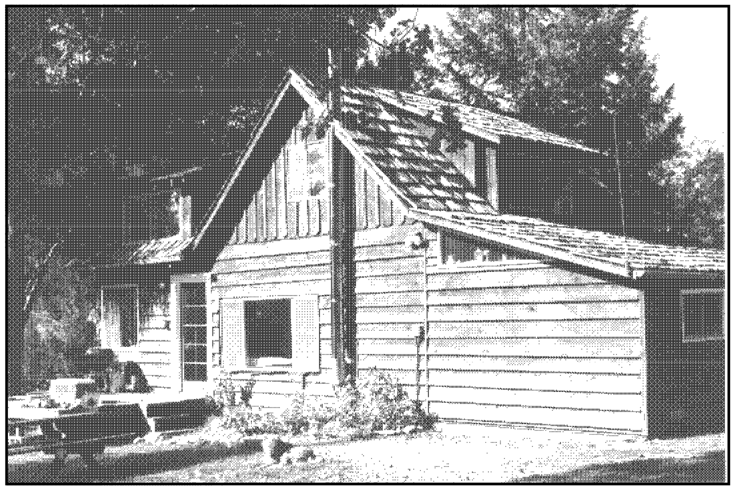
The batteries are located in an insulated box on the back porch. The pack is made up of four Trojan T220 lead-acid, golf cart batteries. The pack is wired for 440 Ampere-hours at 12 VDC. This system uses no voltage regulation and Jody has to be careful not to overcharge the batteries. Jody uses all power from the system via his Heart 1000 inverter. He also uses a gas generator for power tools and the washing machine. These tools require 120 vac and more power than the 1000 watt inverter can deliver.

Jody and Liz have used this hydro system for their power for the last nine years. They report the same biannual alternator rebuild period. Jody runs a fishing and rafting guide business on the Klamath River called Klamath River Outfitters, 2033 Ti Bar Road, Somes Bar, CA 95568 • 916-469-3349. Liz is just about finished her schooling and will soon be a Registered Nurse.

What the Kennedy Creek Hydros have discovered

Hydroelectric systems are more efficient the larger they get. The smaller systems have the higher power costs. The largest system, Gene Strouss's, operates at an incredibly low cost of 3¢ per kilowatt-hour. And that's the cost computed to date. Gene fully expects his hydro system to produce electricity for years to come.

Maintenance in these systems is low after their initial installation. While installing the pipe takes both time and money, after it's done it is truly done. Only regular maintenance reported was bearing and brush replacement and trash rack cleaning. The battery based DC hydros all showed signs of battery overcharging. Voltage regulation is the key to battery longevity in low voltage hydro systems.



Above: Jody and Liz Pullen's home. Photo by Richard Perez.

A parting shot

As Bob-O and I were driving down Ti Bar Road on our way home, we passed the Ti Bar Ranger Station run by the US Forest Service. They were running a noisy 12 kw. diesel generator to provide power for the ranger station. Which is strange because they are at the very bottom of the hill with over two thousand feet of running water above them. And they have five neighbors above them who all use the hydro power offered by the local creek.

The practical and effective use of renewable energy is not a matter of technology. It is not a matter of time. It is not a matter of money. Using renewable energy is just doing it. Just like the folks on Kennedy Creek do.

Access

Author: Richard Perez, POB 130, Hornbrook, CA 96044 • 916-475-3179.

Hydro Systems: Person's Name, Ti Bar Road, Somes Bar, CA 95568.

DC Hydroelectric turbines mentioned: Harris Hydroelectric, 632 Swanton Road, Davenport, CA 95017 • 408-425-7652.

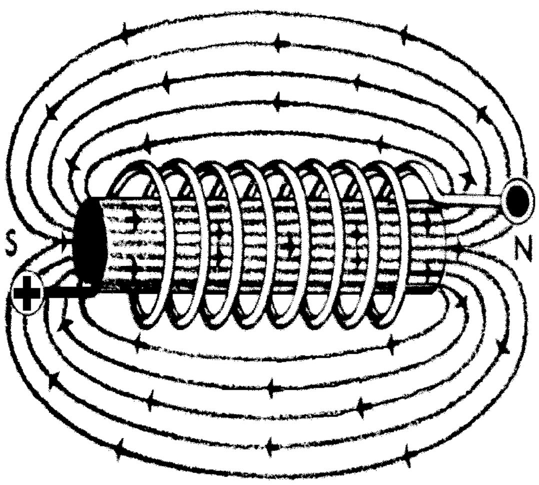
Yer Basic Alternator

Bob-O Schultze - KG6MM

Kilowatt for kilowatt, using water to spin a generator or alternator has long been recognized as the most cost-effective way to make electricity. Given that fact, it comes as no surprise that most home power folks who have the potential to generate hydroelectricity do so. By far, the greatest number of these DC generating hydrosystems use a common automotive-type alternator, just like the one under the hood of your favorite go-mobile. Let's take a look into an alternator and see what makes it work.

Electricity and Magnetism

To understand how an alternator works, let's review some electrical fundamentals. When you pass an electric current through a conductor, such as a copper wire, concentric circles of magnetism are created around the wire. As we increase the current in the wire, this "magnetic field" grows in strength or intensity. Unfortunately, no matter how much current we pass thru a straight conductor, the field around it is too weak to be of value for most applications. If we take this straight conductor, however, and wind it in a series of loops to form a coil, the magnetic field intensifies greatly and "poles" are produced at each end of the coil. These poles are called North and South. The magnetic lines of force leave the coil at the North pole and re-enter the coil at the South. If we take an iron core and place it inside this coil, the magnetic field produced by current passing thru our conductor is intensified further still, since iron offers a much easier path for magnetism to pass through than air, the magnetic lines squeeze down, become more concentrated, and stronger. Now we've got something to work with!

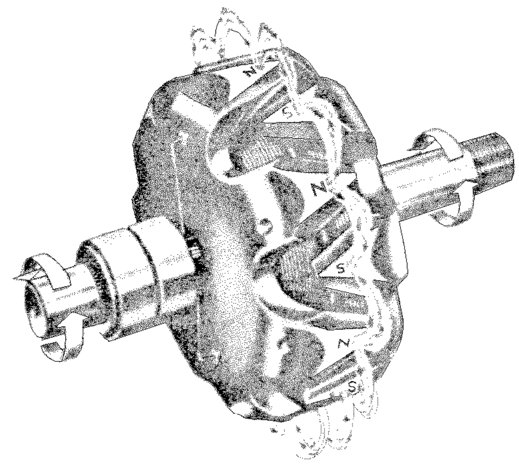


Yer Basic Alternator

An alternator consists primarily of a rotor, a stator assembly, and a couple of end frames to hold the stator and rotor bearings so everything is properly spaced yet doesn't crash into one another. The end frames are also a handy place to stick a few other necessary parts like brushes and diodes.

The Rotor

In our alternator, we take this coil and core electromagnet and mount it between two iron segments with many interlacing "fingers" which each become "poles". When current is passed thru our conductor, each of the fingers being on opposite sides of the wire, pick up the "Pole-arity" of that pole. Consequently, the fingers are polarized N-S-N-S-N-S etc. When we spin the rotor, the polarity of



the magnetic field passing a given point is alternating between N and S at any given time. This is known as an alternating magnetic field, get it? Add a set of smooth copper slip rings on one side of the core connected to either side of our coiled conductor so we can feed some "field current" into our "field winding", spin the whole shebang, and off we go!

The Stator

The stator is really nothing more than 3 wire conductors spaced evenly around a ring of iron. Which gives us 3 of the coil/core combos with the ring of iron acting as the common core for all the windings. Each of the wires is formed into a number of coils spaced so that a coil of wire made from conductor #1 is followed by a coil from #2, followed by #3, followed by a coil from #1, and so on. This is known as a 120° (apart) three-phase winding. On most automotive alternators, one end of a coil is tied together with an end of each of the other coils of wire and is grounded to the frame. The three remaining ends go to the diodes.

The Diodes

An alternator produces alternating current (ac). To use it to charge our batteries we need to "rectify" it to direct current (DC) The diodes, or rectifiers as they're sometimes called, are a series of electrical one-way valves. They allow current to pass one way and block it from coming back. When installed on a line carrying ac, they pass one half of the ac wave and block the other half, changing the ac to a "pulsating" DC. With the addition of a filtering capacitor to "smooth out" the pulse, we have DC clean enough to charge batteries, play rock 'n roll, or whatever.

The Brushes

The brushes sit on the slip rings of the rotor and maintain electrical contact with the field coil while the rotor is spinning. Wires connected to the brushes and to a battery provide the field current necessary to make the field magnetism of the rotor.

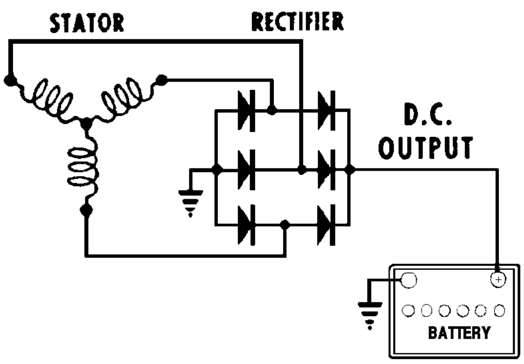
How it Works

When we provide a small field current to the rotor and spin it, whether by water pressure or the fan belt of your Chevy, a strong magnetic field is formed at the rotor fingers or poles. As the rotor passes by the loops of wire in the stator, the magnetic field cuts across each wire, causing voltage and current to be "induced" into these stator windings. Because the poles of the rotor alternate first South, then North, then South again, etc., the voltage induced into the stator windings also alternates between "+" or positive, zero (between poles), and "-" or negative.

In the stator of our alternator, remember, there are three separate windings each consisting of many loops of wire. As the alternating magnetic field from the rotor passes by each winding, a separate voltage, or "phase" is induced in each conductor. Since we have three such conductors in our stator windings, three phase alternating voltage is produced.

Why three phase and not just single phase? Well, you could. In fact, the 110 vac alternator in Gene Strouss' hydrosystem has many coils of a single conductor in its stator. Its output is 110 vac single phase – standard home lighting and appliance power. In our automotive type alternator, however, weight and size are factors.

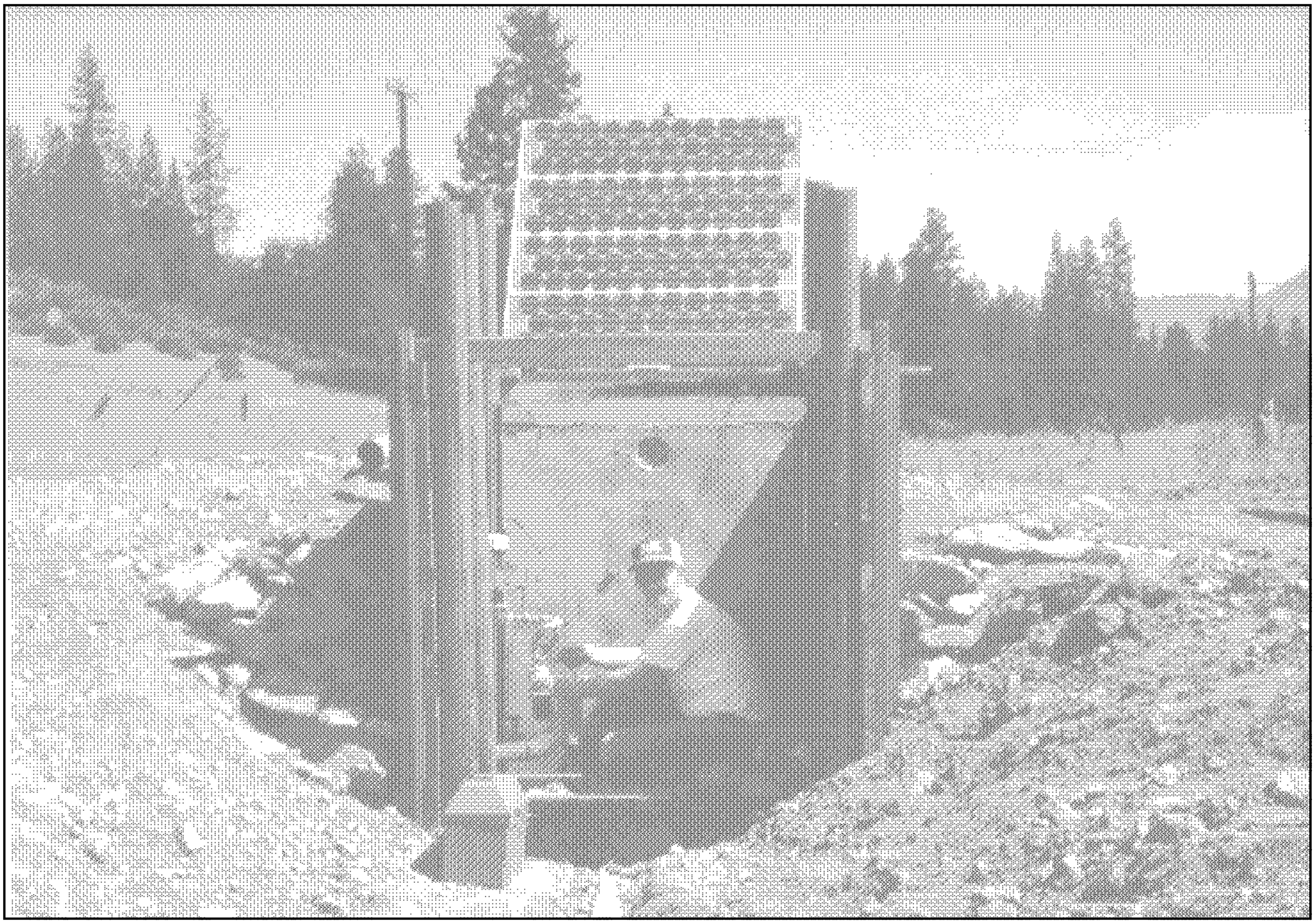
The 3 phase arrangement also gives somewhat more output at lower RPM than single phase and because the phases overlap one another, the voltage waveform after it's been rectified to DC is smoother.



In our alternator, 6 diodes, arranged in 2 banks of 3 each, take the ac voltage and rectify it by passing only the negative half of the ac waveform to ground and passing the positive half to the "+" output terminal of the alternator and hence to the battery. That's it!

Access

Author: Bob-O Schultze, Electron Connection, POB 442, Medford, OR 97501 • 916-475-3401.



Bob Starcher in Fort Jones, CA. A 1200-gallon water storage tank with Flowlight SlowPump & 4 ARCO Photovoltaic modules.
Photo by Sue Starcher.

Experiment at Table Mountain

Bob and Sue Starcher

We decided to make owr own power since we were Camp Hosts in a remote campground in the San Gabriel Mountains of Southern California. And since the campground had no electricity for the hosts to hook up to. The purpose of this experiment was to test the PV panels we purchased for use at our retirement home in Northern California.

The Setting

We were told by Southern California Edison that to run lines down the hill from the ski lodge to Table Mountain Campground would cost $40,000. For this amount, I figured I could put in enough PV panels, batteries, and inverters to run all three RVs and still have money left over. I chose to use the equipment I had already purchased. The power we generated was for the campground Host and Pay Station signs.

The System

The test system I used had six PV panels with a panel rating of 43 watts (≈2.6 Amperes at 16.5 VDC) each. The PV array was coupled to a 380 Ampere-hour, 12 Volt battery bank via the Trace C30-A charge controller. During the month of July, at the peak solar hours of the day, I recorded 14 Amperes of current at the charge controller, which was about 1.5 Amperes less than I expected from the system. The surface temperature of the panels may have reached a point of some de-rating of the voltage and current. I am happy with the overall performance of these panels. I purchased them at an electronic swap meet for a very reasonable price of $1,035 or $172.50 each. This is approximately $4.00 per Watt. If I figure the cost per watt on the actual power I seem to be getting 14 A X 16.07 V=225 W=$4.60 per Watt.

The Batteries

I did encounter some problems keeping the battery bank charged during several weeks of partly cloudy days in August. This is where the properly sized battery bank comes into play. As a rule of thumb, I like to use 50 Ampere-hours of battery storage for each Ampere of current output of the PV array. My array puts out 14 amps so 14 A X 50 A-h.=700 A-h. of battery storage. My battery bank should have been 700 Ampere-hours to carry me through the cloudy days. This

would have prevented the controller from shutting off the PV array at 3:00 pm each day when the battery bank had reached the full voltage of 14.4 Volts. The system was not balanced and I was producing more power than I could store.

I chose not to spend the money on more batteries because this was only an experiment. With the 380 Ampere-hours I was working with, I found that with conservation I could recover the charge to a level of 12.55 Volts with one full day of sun. This is approximately 80% state of charge. At one point, the battery was down to 12-12.2 volts, but only for one night. It took three partly cloudy days to bring it back to full charge. During this time of discharge and re-charge, it seemed that only bi-weekly checks of water usage were needed and only normal small amounts of water were added. I only used 1/2 gallon of distilled water in two months.

The PVs

During the installation of this system, I placed the PVs on a ground mounted wooden rack and placed them at 6° east of true magnetic south with my compass. With the help of a friend, who is a radio amateur, we worked up a chart for tilt angle for the Los Angeles area. I set the PVs at 30° for the end of June. Our chart says 27.5° on June 22. On September 2nd I re-set the PVs at 35° and our chart says 35° is where they should be set for September and March. I didn't find a drastic change in output with the elevation change. For a fixed mount, I believe it should be adjusted four times each year, minimum. These times should be December 22nd, March 22nd, June 22nd, and September 22nd. Our angles worked out to be December 42.5°, March and September 35° and June 27.5°.

I used #14 stranded wire to wire the panels and #4 stranded wire to make the 55 ft. run to the battery. I used #8 solid copper wire to ground the PV frames and negative output line to an 8 ft. ground rod driven into the ground. This was done to prevent lightning damage to the panels and charge controller.

Controllers and Inverter

The battery bank, charge controller and meters were mounted on the front of the trailer as a convenient place to house these items and get the 12 volt power into the trailer.

The system provided an average of 1250 watt-hours per day for the months of June, July and August. The power was used to run my 19 ft. trailer (black and white TV, amplified antenna, and DC lights) and two 25 watt incandescent 12 volt lights on the Camp Host signs.

We used the Trace to power Sue's portable Singer sewing machine and a 19" color TV during the day. The Trace also kept the rechargable Dust Buster and my razor charged. We were able to use the inverter to provide home comforts to some of our visiting campers, such as shavers, hair dryers and curlers. Boy, did their eyes bug out when the generator made no noise and required no gasoline!

I found no noise or RF interference from the Trace inverter. The system works very well for RV use.

Component List

1	Trace 2012 inverter	$1,090
6	43 Watt PV panels	$1,035
1	Trace C-30A charge controller	$75
2	US - 2200 6 Volt used golfcart batteries 220 A-h. @	$50
2	Homebrew wooden PV racks, hardware & wire	$45
1	110 ft. of #4 wire	$30
1	0-15 Voltmeter	$15
1	0-30 Ammeter	$15
2	Group 24 used RV batteries 80A-h @	$0
1	set inverter cables (free with Trace inverter)	$0
	Grand Total	$2,355

Conclusion

I learned one very important thing. The battery bank in a PV system CAN BE the weak link in the overall system if it is NOT sized properly to take care of the cloudy days and cooler than AMBIENT temperatures. The PV system and battery storage must be sized to match each other as well as the climate. The entire system MUST BE BALANCED.

I am also working on a PV system for my retirement home located near Fort Jones, California. We are presently hooked up to the grid, but our plan is to disconnect 40% of the home from grid power by the summer of 1991. The system for our home includes the equipment listed in this article and also eight more Arco ASI 16-2000 PV panels, a Flowlight SlowPump™ and a Flowlight Booster Pump. I still have to buy the batteries for the house. The slow pump will operate directly from the PV panels.

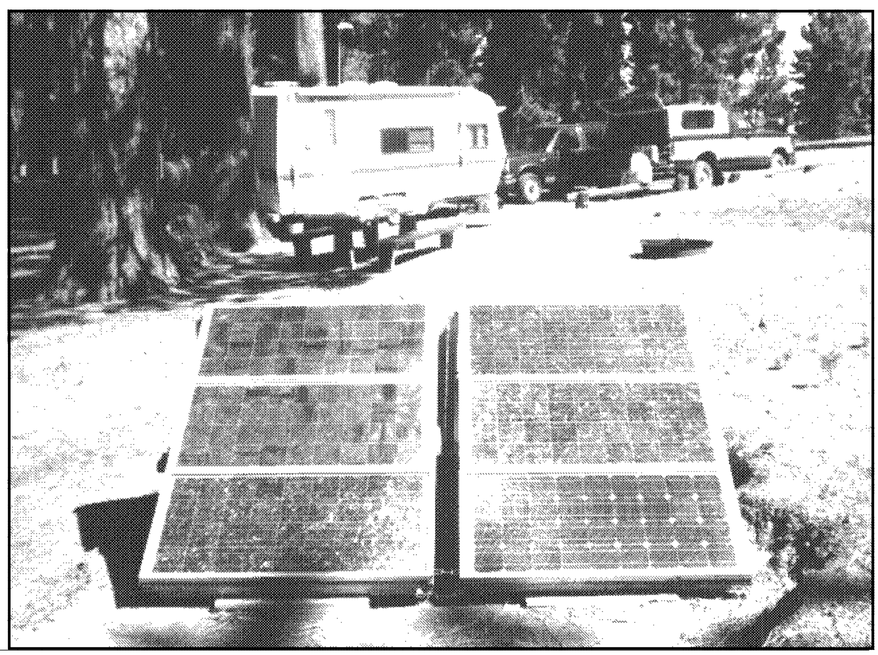
ACCESS

Author: Robert L. Starcher, 422 W. Alosta SP-40, Glendora, CA 91740 • 818-914-4812.

PV panels, charge controllers, inverters and battery data: REAL GOODS TRADING CO., 966 Mazzoni Street, Ukiah, California 95482

Charge controllers, inverters & meters, system sizing: ALTERNATIVE ENERGY ENGINEERING, INC., POB 339, Dept. G, Redway, CA 95560

Below: six PV modules on homebrew wooden ground mounting racks.
Photo by Bob Starcher.



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Above: Allen Schultze uses an 11 watt OSRAM electronic light bulb to do his homework. The bulb is screwed into a standard desk lamp and powered by an inverter. It gives Alan all the light he needs. The power source for Allen's home is sunlight, his family uses a photovoltaic array to make their power. Alan uses a small PV module and battery to power up his radio/cassette shown on his desk. Photo by Richard Perez.

Lights at Night

Using Electronic Light Bulbs on Inverters

Richard Perez

With Winter's short days upon us, now is the time to consider how we are making our light at night. Shorter days mean not only more hours of lighting use daily, but also reduced power production from PV modules. Here is information about applying a type of high efficiency light. These compact fluorescent lights, called "electronic light bulbs", are screw-in replacements for regular incandescent lamps. They not only save power, but they are silent, have near daylight correct color rendition, and run without a trace of flicker. And here's the best part– they operate very well on inverters.

Lights at night…

The use of artificial lighting at night goes back to the campfire, through candles & oil/gas lamps and into the age of electricity. More than one historian claims that the development of civilization was in no small part attributed to lights at night. Lighting provides the opportunity to work, learn and play when the sun's down. All factors contributing to the development of language, art and culture.

Our need for light at night hasn't diminished over the ages. It has increased. And our ability to make the light we need has also grown. Technology has reached the point where we need not use extravagant amounts of power to have lights at night. What we need is to realize the options that technology has offered us.

The first major advance in electrical lighting was the incandescent lamp. The lamp (invented by Thomas A. Edison in the dim mists of history when General Electric's major product was light bulbs not progress) heats a filament into incandescence. The major physical effect of the incandescent lamp is not light, but heat. Over 94% of the electricity pumped into an incandescent lamp goes into heat, the remaining >6% of the power is converted into light.

Enter the fluorescent lamp. The fluorescent lamp uses a glass tube that is internally coated with phosphors. Phosphors are chemical compounds that emit visible light when in the presence of electric fields. A special electronic circuit, called a ballast, was used to convert the 120 vac power to excite the fluorescent tube (see George Patterson's article in this issue for techie details on ballasts). Fluorescent light is four to seven times more efficient at converting electricity to light than are incandescent lights. Well, great! Except that early fluorescents had several major warts. One, they gave off a bluish light that made everyone look pale and corpse-like. Two, they gave off a flickering light because they were powered at 60 cycles per second (the human eye can perceive a flicker at about 30 Hz directly and over 70 Hz. subliminally). And three, they buzzed like banshees when fed inverter-produced power. Well, some bright engineers have come up with solutions to all three of these problems.

The OSRAM Dulux EL Lamps

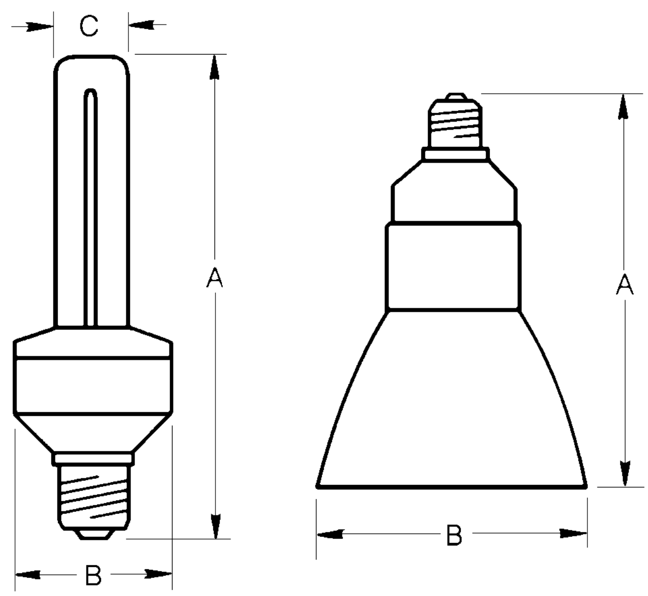
These lamps are a significant advance in the use of phosphors to make light. One, the EL lamps use a particular phosphor coating which produces light that is color correct and virtually indistinguishable from daylight. Two, they use a switching type electronic ballast that operates at 35,000 cycles per second instead of 60 cycles per second. This high frequency ballast eliminates all traces of flicker in light output. And three, they love running on inverters. They operate silently on inverters. They will boot most inverters from standby mode into operating mode.

The EL lamps have standard light bulb bases and will screw into any standard light bulb socket. And that includes Aunt Millie's 1920 ceramic table lamp with the bronze gilt fruit on the base. What follows below is a table describing the various OSRAM EL lamps. The EL-R11 and EL-R15 are equipped with a reflector and function as spot or task lights.

In this table, there is derived data about the EL lamps savings of electricity and money. That's right, not only do they work well, but they also save money by saving electricity. And that not only saves us money, but also the environmental pollution associated with making that electricity. The column headed "Equivalent Incandescent Lamp Wattage" is just that- for example, consider the EL-15 lamp. In order to get the same amount of light provided by the 15 watt EL-15, you will need to use a 60 watt incandescent light bulb. The next column to the right computes the amount of electrical power (in kiloWatt-hours) that the EL lamp saves over its 10,000 hour lifetime. Next follows the dollars saved columns. This is computed on the basis of 10,000 hours of operation (for example a single EL-15 will outlast 10 regular incandescent bulbs). Note that grid users save money with these lamps at a dirt cheap electricity cost of 12¢ per kiloWatt-hour (actually it costs all of us much more, but the grid is not yet charging for environmental consequences). Renewable energy users pay more (about 85¢ per kiloWatt-hour) for their electricity, and thereby they save much more by using efficient lighting.

OSRAM Dulux EL Electronic Light Bulb Data

Lamp Type	Lamp Cost	Lamp Wattage	Lamp Dimensions- Inches			Equivalent Incandescent Lamp Wattage	Power saved over lamp's lifetime in kWh.	Dollars saved on GRID 12¢ / kWh.	Dollars saved on RE 85¢ / kWh.
			A	B	C				
EL-7	$23.95	7	5.69	2.25	1.06	25	180	$1.65	$133.05
EL-11	$23.95	11	5.69	2.25	1.06	40	290	$14.85	$226.55
EL-15	$23.95	15	6.88	2.25	1.06	60	450	$34.05	$362.55
EL-20	$23.95	20	8.19	2.25	1.06	75	550	$46.05	$447.55
EL-R 11	$29.95	11	5.88	4.88		50	390	$26.85	$311.55
EL-R 15	$29.95	15	7.25	4.88		75	600	$52.05	$490.05

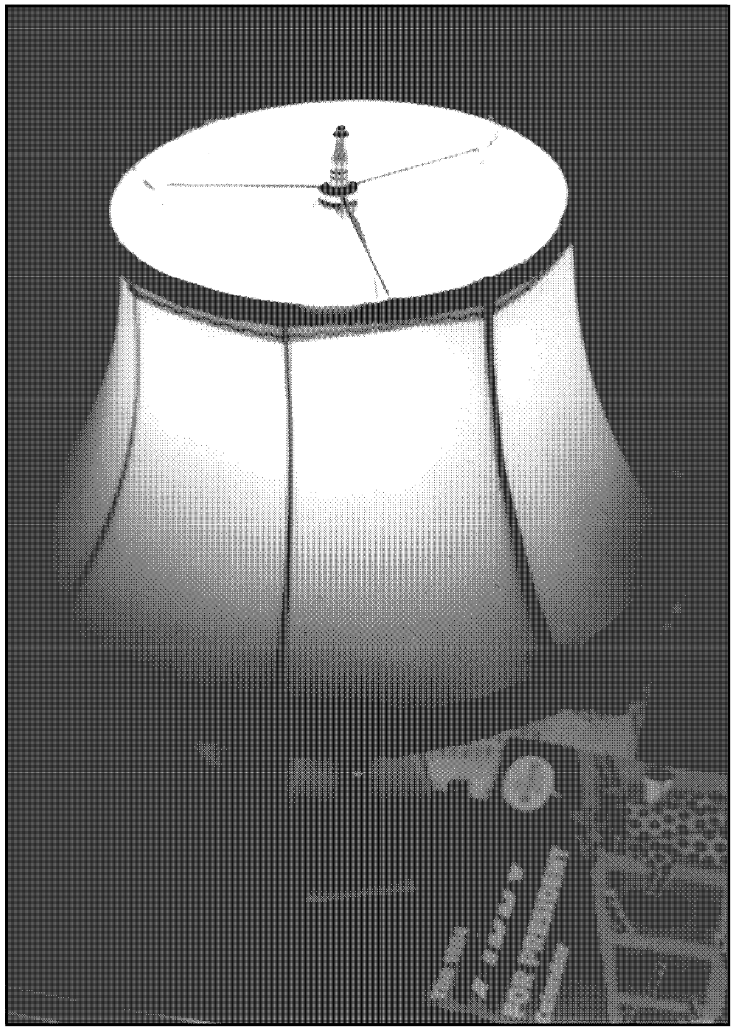


Let's examine the scenario of replacing the 60 watt incandescent bulb in Aunt Millie's table lamp with a EL-15. The EL-15 will save 450 kiloWatt-hours of electricity during its 10,000 hour life. Assuming that the EL runs four hours daily, this amounts to 6.8 years of operation. During that time, the EL-15 will save the grid connected user about $34. It will save the renewable energy powered user about $362. It saves our atmosphere tons of carbon dioxide and pounds of sulphur dioxide. All this from intelligence applied to Aunt Millie's table lamp.

What about 12 Volt DC fluorescent lighting? At Home Power, we have tested virtually every type of DC fluorescent made. They have problems. One, they are 12 Volt and require the special wiring treatment used in low voltage circuits. Heavy wire is expensive and difficult to retrofit. Two, they may use hard to find fluorescent tubes that are mostly not even close to color correct. And third, they cost about TWICE as much per light as the EL types. This is because each low voltage fluorescent contains its own micro inverter. And this point is the death-nell of low voltage fluorescents. It is far cheaper to buy a small power inverter (120 Watts) and power six EL lamps than it is to purchase and install six comparable 12 VDC fluorescents. With more and more systems going to a large inverter supplying power for all use, these electronic light bulbs fit into the wiring and constant inverter operation scenario. This price difference is built into the use of phosphors for lighting. Phosphors require require high voltage ac excitation to operate. So whether you buy a 12 VDC or a 120 vac fluorescent, you are buying and using an inverter. It is simply more cost effective to use one larger inverter than it is to use a small inverter built into each and every fluorescent light. A last factor is longevity. In our experience, low voltage fluorescents have had short lifetimes (<2,000 hours). The quality of the construction, and thereby reliability, in the low voltage fluorescents has not approached that of the Dulux EL units.

Inverter testing of the OSRAM Dulux EL Lamps and others

Basically, we took all the EL series lamps mentioned in the table and plugged them into as many different types of inverters as we could get our hands on. Actually, we also had compact fluorescents by five other manufacturers to test at the same time. I'm not going to waste your time and our paper with those that didn't work, so I am writing about the best of the lot, the OSRAM EL units. We measured the lamp's power consumption on the inverter and compared it to operation on sine wave power input. We installed the ELs in every place possible in two homes, one where Karen and I produce Home Power, and the other where Bob-O and Kathleen run Electron Connection. Bob-O and Kathleen's home is a very good test because all of their lighting is powered by 120 vac via the Trace 2012 inverter. We lived with the lamps.



Above: Aunt Millie's Lamp saves big bucks with an OSRAM 15 watt electronic lightbulb. Photo by Richard Perez.

We use two Fluke 87 DMMs to make these measurements. We tested the EL series on the following inverters: the Trace 2012, the Heliotrope 2.3 kW. WF Series, the PowerStar 200, the Statpower 100, the Statpower PROwatt 600 and the Heart 1200. In all cases, the smallest 7 watt EL was able to boot the inverter and hold it on for operation. The EL series lamps started instantly on all these inverters. Several other types we tested went into a 20 second flashing indecision period before starting, while others never did

120 vac Fluorescent Light Comparison
all lights powered by a Trace 2012 Inverter

Manufacturer	*Model*	*Fluorescent Tube Type*	*Rated Fluorescent Tube Wattage*	*Entire Lamp's Consumption at 120 vac in mA.*	*Entire Lamp's Actual Wattage*	*Lamp's Efficiency Tube Watts / Watts Input*
OSRAM	EL-15W	T-4	13	157.5	19.01	68%
Sylvania	FC 800	FC8T9 CB/RS	22	277.0	33.43	66%
OSRAM	EL-R15W	T-4	13	165.1	19.93	65%
OSRAM	EL-11W	T-4	9	118.7	14.33	63%
Lights of America	5000 1B	FC8T9 WW/RS	22	293.0	35.37	62%
Philips	SL*18/R40	T-4	20	319.7	38.59	52%
General Electric	FCB 401	FC8T9 WW	22	406.0	49.00	45%

start without first booting the inverter. The EL series operated absolutely silently on all these inverters. We tried the exact same lamps on the other inverters and they were dead quiet.

Good Places to use ELs

TIME: In any light that spends more than 2 hrs/day on. Period.

IN EXISTING FIXTURES: Their small size make them naturals for existing incandescent lamp fixtures. The only places we had trouble putting the EL lamps was in some recessed ceiling fixtures. I have included the lamp physical dimensions in the table so you can figure if it will fit or not. In most cases we tried here, they fit. The EL lamps will screw easily into most desk and table lamps.

WHERE YOU NEED BRIGHT LIGHT: I installed one of the 15 watt reflector models in a clip-on fixture above Karen's work area. This EL-R 15 spends about eight hours a day operating. Karen does a lot of paperwork and her eyes appreciate the bright, natural, silent and flicker-free light. The design and execution of the reflector alone is precise and amazing. We have started and run this particular EL-R15 when it was at temperatures as low as 30°F. We noticed that it takes all EL lamps about two minutes to warm up and produce their maximum light output when they are cold.

Bad Places to use ELs

Any lamp that is repeatedly turned on and off (like the light in the pantry). The lifetime of the EL is primarily determined by its starting circuit. OSRAM rates the 10,000 hour lifetime of the EL series on the basis of three hours of continuous operation per turn on. If you switch the light on and off many times daily, then the EL's lifetime will be shorter. ELs are not suited for low temperature environments, like unheated spaces in cold climes. At sustained low temperatures, the higher efficiency of the EL is not realized.

Techie Details

I am going to refer you to George Patterson's article which follows this one. George showed up here one weekend with several large cardboard boxes full of every different type of compact fluorescent available. We then proceeded to test each one on every inverter. It took all weekend and we learned more than I can cram in here.

Bottom Line Time

If you are making your own power, you can save very big bucks by using efficient lighting. Every Watt you save is a Watt you don't have to produce, store or convert. This adds to fewer batteries, fewer PV panels, and smaller, more cost-effective systems.

If you rent your power from the grid, you can save small time bucks by using efficient lighting. What you can save big time is our world. The kiloWatt-hours of electric power going down the throats of your light bulbs have expensive consequences. Conservation is the most potent tool we have against the environmental, financial, & political effects of our energy dependency.

And after all, it's not like we have to give anything up to use efficient lighting anymore. The quality of the light that these efficient lamps produce is the best ever. Only thing better is sunlight.

Access

Author: Richard Perez, C/O Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179. I wish to make it clear that: 1) I don't sell these lights, 2) I'm not paid by OSRAM, or anybody else, to say nice things about these lights, and 3) All I get out of this is a warm feeling that you are not wasting your power and thereby our planet.

Makers of the ELs: OSRAM, 110 Bracken Road, Montgomery, NY 12549-9700 • 800-431-9980 • 914-457-4040.

Energy-Efficient Lighting- Compact Fluorescents on 120 VAC

George Patterson

Compact fluorescent lights are one of the most energy-efficient lamps available on the market today. They produce 3 1/2 times more lumens per watt than incandescent lights and 7 to 13 times the lamp life of a standard "A" type incandescent. The lamps use 70% less power than standard incandescents. Modern types use high frequency electronic ballast and produce silent, flicker-free light. These lamps are color correct. They produce light that is a very good imitation of daylight. We are seeing a revolution in lighting!

Compact Fluorescent Lamp Data

The data in the table shows performance data for six compact fluorescent lamps and two types of incandescent lamps. Lumens are a unit of light intensity and ranks the lamps by brightness (the higher the lumen value the more light the lamp produces). Lumens per watt shows how efficient the lamp is. Note that the compact fluorescents are about six times more efficient than incandescents. The lifetime (in hours) is rated by the manufacturer assuming that the lamp remains burning for three hours when switched on. Minimum starting temperature is just that, the lowest temperature at which the lamp will reliably start. Color temperature is a scientific system for measuring the spectral output of a light producing object. In the color temperature scheme, the object color is related to a black body at a certain temperature in degrees Kelvin (°K.). The color rendition index is more easily understood. The color rendition index of daylight is 100 by definition. The closer a lamp's color rendition index is to 100, the closer its color is to daylight. OK! Are all of these lamps real? How do they apply to real life?

Compact Fluorescent Lamp Data

Lamp Type	Initial Lumens	Lumens per Watt	Lifetime in hours	Min. Start Temp.	Color Temp.	Color Index
7w. twin tube	400	57	10000	0 °F.	2700 °K.	82
9w. twin tube	600	67	10000	25 °F.	2700 °K.	82
13w. twin tube	900	69	10000	32 °F.	2700 °K.	82
13w. quad tube	860	67	10000	32 °F.	2700 °K.	82
18w. quad tube	1250	69	10000	32 °F.	2700 °K.	86
26w. quad tube	1800	69	10000	32 °F.	2700 °K.	86
25w. Incandescent	260	10	1500		2500 °K.	91

The fluorescent light as a system

The lighting fixture is truly an energy system with four elements - 1) Input power, 2) Ballast, 3) Starter, and 4) Fluorescent tube. The efficiency and performance of the system is dependent on the interaction of all four elements. Change any one element and the light's performance and efficiency changes.

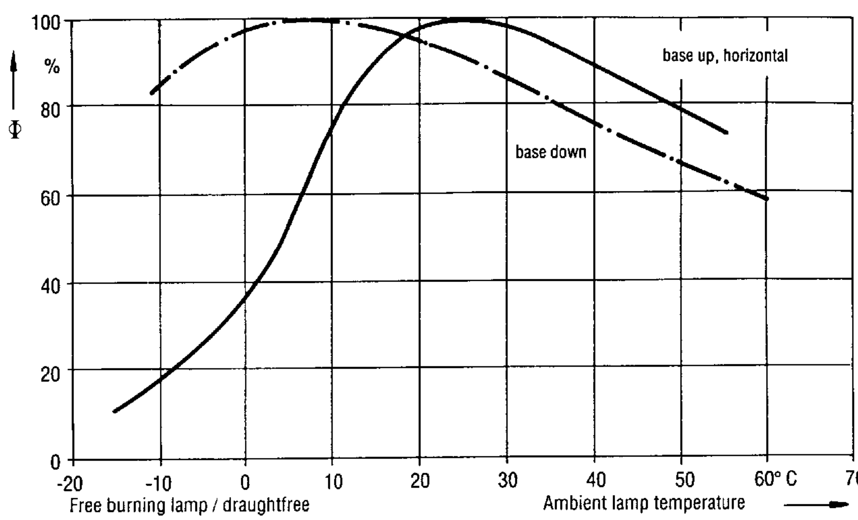
The reality of lighting is that we are not going to get something for nothing. Of course, in trying to do so we are likely to take ourselves to the cleaners. There is no substitute for doing our homework and making decisions based upon actual experiences. The 10,000 hour life figure quoted for most compact fluorescent tubes is just a starting point. The truth is that we may get anywhere from 2,000 to 20,000 hours from the same tube depending on the ballast type and operating environment. The light output from a 13 watt compact fluorescent tube may be 900 lumens at 75° F (100%), 720 lumens at 120° F. and 450 lumens at 40° F. This is especially a problem where housings and lighting fixtures trap heat inside, or they are used outdoors in the cold.. A typical graph of the operating temperature characteristics is shown at right. Note that the efficiency we seek so dearly is affected by the position of the base.

Ballast and tube life on inverters (square wave) may be cut in half compared to use on true sine wave for 120 VAC applications. On modified sine wave inverters there are no known problems, but the jury is still out.

Tube Life and Starting

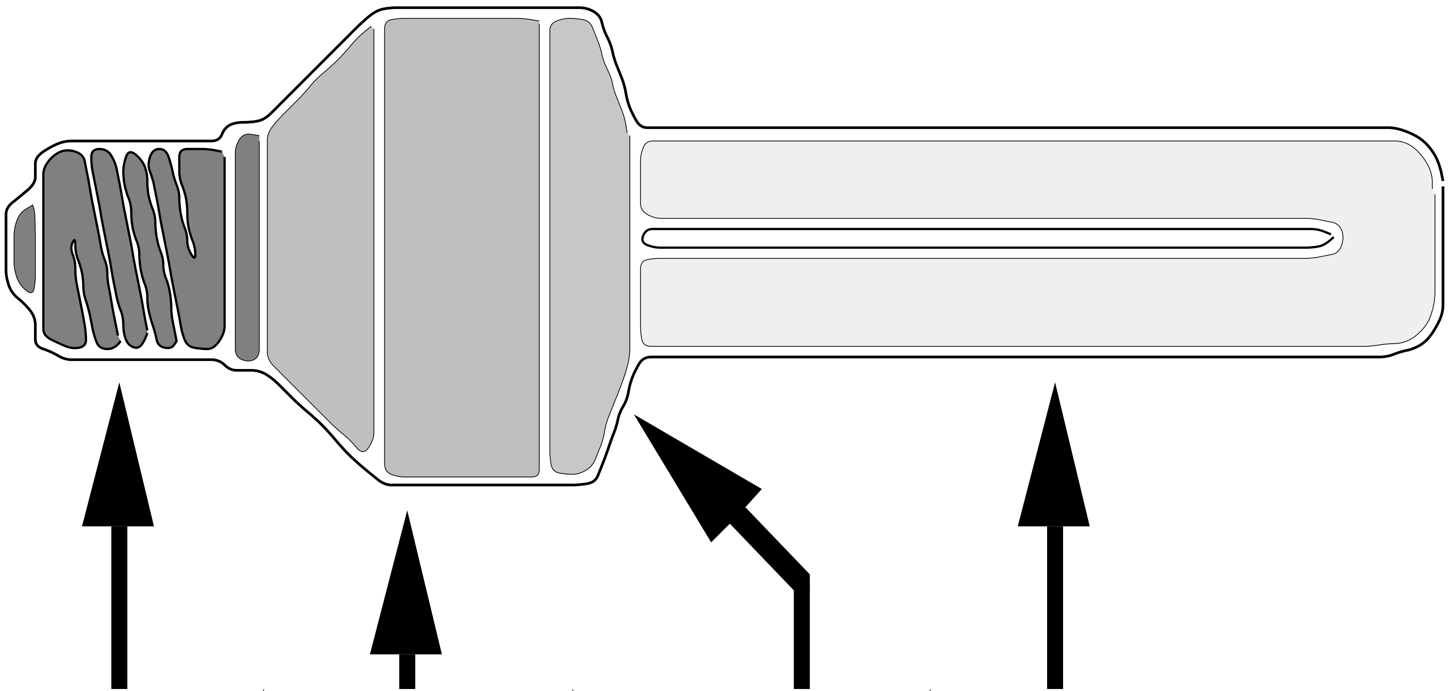
The electronic ballast may deliver promised efficiency, but the design of the starting circuit is critical. Some compact fluorescent tubes have built in glow discharge starters, while others use pre-heat filaments for starting. Pre-heat filaments require external starting circuitry. Life of compact fluorescent tubes designed for use

Temperature characteristics
DULUX® S 5W, 7W, 9W, 11W, 13W
DULUX® S/E 5W, 7W, 9W, 11W
DULUX® L 18W, 24W, 36W



Fluorescent Lighting is a System

for it to give color correct, efficient & long-lived light all parts must be in proportion and harmony



INPUT POWER	**BALLAST TYPE**	**STARTER TYPE**	**PHOSPHOR TYPE**
maybe from: Grid or Inverter or Generator	maybe: High Freq. electronic or Low Freq. Electronic or Coil & Capacitor	maybe: Glow Discharge or Pre-heat Filament or Rapid-start Filament	maybe: Color Correct or maybe not.

with external starting circuits (rapid start, pre-heat, and electronic ballasts) is determined by the design of the starting circuit. The life of a fluorescent tube with built-in glow discharge starter is primarily determined by the life of the starter. Starter life in these tubes varies widely with ballast design. If the fellows that designed the ballasts did a good job, then the starter will last the 10,000 hour life of the tube. If the ballast is not properly designed we can expect life times as short as 2,000 hours.

Ballasts

The newly-developed high power factor coil capacitor ballasts for 120 VAC have energy efficiencies similar to electronic ballasts. When operated at normal AC line frequency (60 Hz.) the color temperature is 2700° K. By operating compact fluorescent lamps on an electronic ballast at high frequency, 25 khz to 35 khz, the lamps' phosphors are about 14% to 17% more efficient at producing light and flicker is eliminated. The color temperature drops from 2700°K to about 2300°K.

Very few residential ballast designs address the power factor requirements imposed by fluorescent lamps. Power factor relates to the lag between current and voltage and values less than 1.0 translate into wasted energy. Some ballasts have power factors as high as 0.9, but many fall short with values as poor as 0.2. Normally, coil capacitor ballasts have a power factor of 0.2 to 0.4, however, high power factor (HPF) designs achieve values as high as 0.9. Electronic ballasts usually have power factors above 0.6 and the more expensive and bulky designs above 0.9.

The OSRAM Corporation, a Siemens company (the same people that purchased ARCO Solar!), is one of the industry leaders in both compact fluorescent lamp and electronic ballast manufacturing. Osram has a line of 12 VDC and 120VAC/DC ballasts that are available only in Europe. These commercial grade electronic ballasts have a power factor greater than 0.9, and will soon be available in the USA in 5 to 26 watt sizes.

Dulux EL Electronic Light Bulbs

Residential grade OSRAM DULUX™ EL lamps (Electronic Light Bulbs) are available in the USA right now. These are for retrofit applications and have medium bases that replace incandescent light bulbs. These lamps may be used on inverters at 120VAC and there is no hum! The power factor for these DULUX™ Electronic Lightbulbs is 0.6 to 0.7. Its built-in ballast is designed with a full wave bridge rectifier capacitor input filter followed by a 35 kHz oscillator to drive the fluorescent tube. All of this is integrated and the expected tube life and ballast life is well matched. As a result of this design, these electronic light bulbs may be operated on DC or 120VAC. Since the capacitor acts as a peak detector of the 120 V RMS AC, the DC required would be around 165 V. This may be only interesting, but I thought that I would mention it. Also, these electronic light bulbs have received FCC Part 18C certification for residential use. This means that they aren't going to interfere with radios or TVs. Most magnetic ballasts have never been tested by the FCC, they can be very noisy and interfere with radios and TVs.

We have learned that coil capacitor ballasts produce much more

heat than electronic ballasts. In fact, to get UL approval, a compact fluorescent light must operate with an internal temperature below 120 °F. The lighting industry is developing low temperature electronic ballasts. They cost more, but have advantages. If we let the fixture manufacturers know we want efficient, long-lived lights, they are with us.

Conclusions

Compact fluorescent lighting systems are much more efficient than incandescent lighting. We see about four times the lumens per watt as compared to incandescent. There are more efficient systems than the compact fluorescent, but they usually aren't suitable for indoor use. Recently, fluorescent lighting has become much better at color rendition and can start almost as rapidly as incandescent lamps. With the emergence of electronic ballasts, heat dissipated in the ballast has been reduced, and the performance of fluorescent lamp starting improved.

Why bother?

Energy savings!!! & $$$ Don't forget that your local power utility (maybe even you !) don't have to produce as much energy to feed your lighting needs.

Ecological Benefits!!!

CO_2 from burning fossil fuels adds to the greenhouse effect and global warming. Acid rain kills trees and fish in lakes.

Access

George Patterson, 3674 Greenhill Road, Santa Rosa, CA 95404.

Osram Corporation, 110 Bracken Road, Montgomery, NY 12549-9700. • 800-431-9980 or 914-457-4040

New Life for Sulphated Lead-Acid Cells?

Richard Perez

Over the years I have tried many chemical treatments supposed to rid a cell of sulphation. None of them made any perceptible difference. A strange and devious set of circumstances has led us to the successful chemical removal of sulphation from six lead acid cells. Not only are the circumstances odd, but the chemical used, EDTA, is benign– in fact, it is used as a human food preservative.

The Patients

The sulphated Trojan L-16W lead-acid batteries numbered four and were the victims of a messy divorce. The pack was less than two years old when its owners had a parting of the ways. The husband took off for parts unknown. The wife left the house vowing never to return. And she left ALL the lights on when she departed. This system was sourced only by an engine/generator, with no PVs to help out. After several days the batteries were totally discharged. The batteries then sat discharged, with the lights switched on, for the next three months.

The ailing pack was transported to Electron Connection for disposal as part of the whole divorce rigamarole. Upon inspecting the cells through the filler holes, we say vast amounts of white moss covering all the plate assemblies. Or at least we assumed there were plates in there somewhere because all we could see was an even blanket of moldy looking lead sulfate. Seven of the twelve cells were very low in water. Our job was to assess what these batteries were worth. In order to do this we attempted to recharge them and see how they held the charge. Open circuit voltage of the cells averaged 0.7 Volts.

We placed the batteries on a four panel Kyocera J48 PV array (≈12 Amps) and the voltage immediately shot to 15 Volts where the regulator cut in. The amount of current accepted by the four L-16Ws was 0.4 Amps. We left the L-16Ws on the array for five days, but they never did accept a charge. We then tried discharging the batteries. They (all four 125 pound batteries) ran a 28 Watt car tail light for about three minutes. This gave us an electrical capacity of about 0.05 Ampere-hours per cell that originally had a capacity of 350 Ampere-hours. A classic case of sulphation ruining virtually new, high quality batteries. We pronounced the cells toxic waste and told the principals involved that the batteries were worthless. In fact, worse than worthless because someone had to responsibly dispose of them. The original owners promptly disappeared and left us holding the batteries. They sat, forlorn and unloved, in the battery area, side by side with new cells destined for caring homes.

In another reality…

My friend, George Patterson, a battery techie second to none, ran into an article in an obscure British antique motorcar publication that described using a chemical called EDTA to remove sulphation from old lead-acid batteries. I related to him the story of the orphaned L-16Ws and, to make a very long story short, we decided to give it a try on these virtually new, but severely sulphated batteries.

EDTA, what is it?

It is an organic acid, a chemical cousin of vinegar. EDTA stands for the entire name of the compound which is, "ETHYLENEDIAMINE TETRAACETIC" Acid. EDTA is used for many chemical jobs, but perhaps the most amazing is as a food preservative. I noticed it on the list of ingredients of a can of Slice® orange pop I drank. In chemical techie terms, EDTA is a "chelating agent". That means it likes to bond to metallic ions (like lead sulfate). While EDTA is not the sort of stuff you want to eat by the teaspoon (the label carries warnings about getting it in the eyes or nose), it is a relatively innocuous chemical with which to attack the sulphated nastiness of those L-16Ws. I admit to being skeptical. I thought we were wasting our time. How could something contained in orange pop help these severely sick cells?

The Operation

George Patterson located and purchased 500 grams of EDTA from a local chem lab that specializes in the chemical testing of wine. The cost was low, under $15 for the EDTA and another ten bucks for rush shipping. George then did an essential duty in this entire process. He came up to HP Central in Hornbrook and got me off my butt to actually perform this experiment. George could have shipped me the EDTA, but he knew my faith in this project was so low that I'd get it done some time next century.

We decided to operate on two of the L-16Ws and leave the other two untreated as controls for the experiment. We had only sketchy information from the British motorcar pub. It described a teaspoon in every cell (hold the milk and sugar) and let sit for several hours. It neglected to mention the size of the cell, but George and I assumed that an antique motorcar would have a fairly small battery- about 70 Amp-hrs. So we upscaled the amount of EDTA to 2 Tablespoons to match the larger (350 Ampere-hour) L-16W cells. What follows is a step by step description of what we did:

PLEASE NOTE: These operations involve handling sulfuric acid electrolyte. We used acid resistant Norex lab coats, rubber boots, rubber gloves, and safety glasses. If you try these operations without this safety gear, then you are risking injury. Play it safe.

1 We drained the old electrolyte from all six of the cells. Now this reads easier than it does. An L-16W battery weighs 125 pounds and contains 9 quarts of sulfuric acid in its three cells. Be careful not to drop the battery or spill the acid electrolyte. Reserve the old electrolyte in secure containers and dispose of it properly through your local battery shop.

2 We rinsed all the cells with water and drained them.

3 We added 2 Tablespoons of EDTA to each cell and refilled each cell with hot (≈120°F.) tap water.

4 We left the cells to merrily bubble (the EDTA/lead sulfate reaction is exothermic- it gives off heat) for about two hours.

5 We then drained the cells and repeated steps 2, 3, and 4 once again. We could see the sulphation disappearing, but one treatment had not got it all. Actually, two treatments didn't either because there was still some sulphation there after the second go

round.

6 We rinsed each cell with distilled water and drained it.

7 We refilled each cell with new (sulphuric acid in solution with distilled water- specific gravity 1.260) lead-acid electrolyte.

The Operation was a success?
After spending all day lifting and draining L-16Ws, George and I were sore and ready for a few beers. This technique is not recommended to the frail. If I were to do it again, I would build a cradle to hold and invert these heavy batteries. Doing it by hand is tiresome, risky, and invites injury.

Neither of us was convinced that we had accomplished much beside some heavy sweating dressed in kinky moon suits. We left the L-16Ws, disconnected and unused, in the basement battery area. Every time I passed by, I would wire the pack of two rejuvenated batteries into the PV array for some quickie recharging. I had no time to run any sustained recharging or testing at that point because we had another issue of Home Power going to press.

It was not until six weeks later that Scott Hening, our summer intern, hooked up the EDTA treated L-16Ws into a working system. This system is sourced by two ancient, anemic SolaVolt PV modules. The system is simple: the PVs and the two L-16Ws. This system provides power for lighting in Bob-O's spare trailer which houses dignitaries and heads of state visiting HP Central. Here the EDTA treated batteries received about 3 to 4 amps as long as the sun was shining. Since this system is seldom used, the batteries received a constant daily overcharge for about eight weeks. Bob-O kept on top of the cells' water levels and refilled them as needed with distilled water.

Since the trailer was seldom used, and no one staying there complained of dead batteries, we just left the L-16Ws alone. Since the system had no instrumentation, it was hard to tell how much improvement the EDTA treatment did.

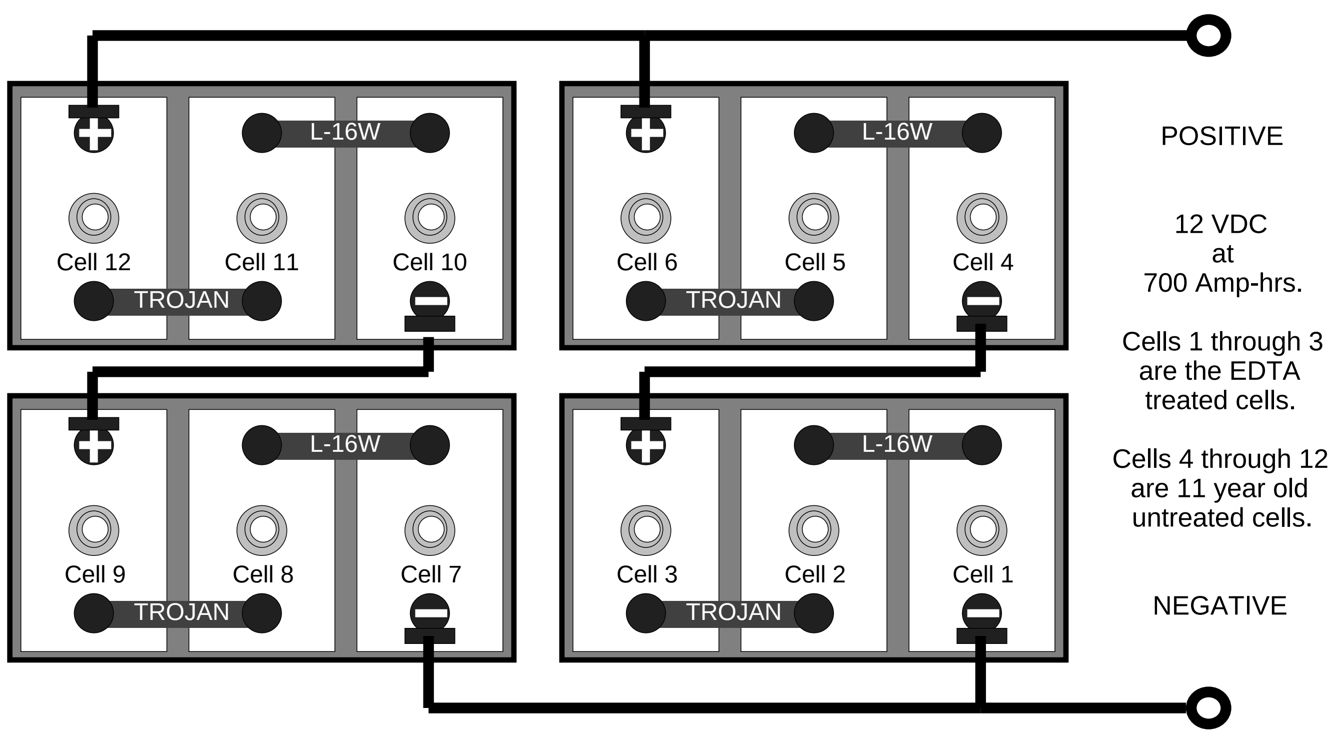
Enter a pressing need
Then all of a sudden (in the space of six days) one of the L-16Ws in the main Home Power system (4@ L-16W) at Agate Flat developed a shorted cell. As distressing as it was to lose an eleven year old L-16W battery, it was fascinating to watch and record the death of one of its cells. The shorted cell dramatically unbalanced the remaining three L-16Ws in the pack. I had to do something quick. I disconnected the series string of two L-16Ws with the bad cell. Putting a new L-16W in this eleven year old pack was out of the question. I started thinking used battery and imagined the EDTA treated L-16Ws. Next day, I removed one of the EDTA treated L-16Ws from Bob-O's trailer and inserted it the main Home Power battery. I had trouble choosing the best of the two EDTA treated batteries. I went for the one that had the least voltage variation between cells.

EDTA treated L-16W performance
I had no idea what to expect. The last time I tested the sulphated L-16W it wasn't able to power up a car tail light. I inserted it into the main pack as follows in the illustration below. I gave each cell a number and recorded data on the performance of the battery on a cell by cell basis. The L-16W battery containing cells 1, 2, and 3 is the EDTA treated battery. The remaining L-16Ws (cells 4 through 12) are the original, untreated, eleven year old batteries.

What happened?
I'll cut to the chase here. The L-16W treated with EDTA had regained enough of its electrical capacity to function as an equal element with the battery. It works! What follows below is data from all cells making up this battery under a variety of conditions. Detailed in the tables on page 25 are a variety of data, here's a score card to help tell the players:

Battery Data
1. the date. 2. the battery Ampere-hour Meter reading which indicates the pack's State of Charge (minus indicates discharge amp-hrs.). 3. the discharge or charge rate in Amperes (minus indicates discharge).

Individual Cell Data
4. the voltage of each cell. 5. the absolute cell voltage deviation from the average cell voltage. 6. the average battery (that's three



cells in a case) voltage deviation. Note EDTA treated cells' data (Cells #1, #2, & #3) are printed in bold type.

Derived Cell Data
7. average cell voltage. 8. cell voltage standard deviation (computed via standard statistical method). 9. maximum cell voltage difference.

What the data means
What we are looking for are differences in voltage between cells. Which is why the average cell voltage and deviations from average cell voltage are computed. A maximum cell voltage difference greater than 0.05 VDC, under light discharge (<C/40) means the cells are unbalanced. This measured by subtracting the voltage of the highest cell from the voltage of the lowest cell.

Note that on all four test discharge runs (10/21/90, 11/2/90, 11/7/90, and 11/19/90) all the cells making up the pack show about the same voltage. In fact, some of the EDTA treated cells are showing higher voltages than some of the non-treated cells.

Bottom line is that the EDTA treated cells are functioning in as a series parallel element in a battery pack. Before treatment these very same cells couldn't store enough power to operate a small light blub for five minutes.

To date I have discharged the test battery to the depth of 214 Ampere-hours (indicated by the Cruising Equip. Amp-hr. meter) from the test battery. The EDTA treated cells are continuing to function within the pack with less than 0.02 VDC difference from untreated cells.

Date: 10/21/90
Amp-hrs. -61
Amperes -6.4

Cell #	Cell Voltage	Absolute Cell V. Deviation	Average Battery V. Deviation
1	**2.051**	**0.00058**	**0.00586**
2	**2.048**	**0.00358**	
3	**2.065**	**0.01342**	
4	2.051	0.00058	0.00325
5	2.051	0.00058	
6	2.043	0.00858	
7	2.051	0.00058	0.00125
8	2.050	0.00158	
9	2.050	0.00158	
10	2.058	0.00642	0.00714
11	2.058	0.00642	
12	2.043	0.00858	

Average Cell Voltage	2.052
Cell Voltage Standard Deviation	0.006244
Max. Cell Voltage Difference	0.022

Date: 11/2/90
Amp-hrs. -53
Amperes -8.4

Cell #	Cell Voltage	Absolute Cell V. Deviation	Average Battery V. Deviation
1	**2.056**	**0.00083**	**0.00594**
2	**2.054**	**0.00117**	
3	**2.071**	**0.01583**	
4	2.052	0.00317	0.00583
5	2.053	0.00217	
6	2.043	0.01217	
7	2.054	0.00117	0.00117
8	2.054	0.00117	
9	2.054	0.00117	
10	2.062	0.00683	0.00728
11	2.062	0.00683	
12	2.047	0.00817	

Average Cell Voltage	2.055
Cell Voltage Standard Deviation	0.007259
Max. Cell Voltage Difference	0.028

Date: 11/7/90
Amp-hrs. -29
Amperes -2.5

Cell #	Cell Voltage	Absolute Cell V. Deviation	Average Battery V. Deviation
1	**2.114**	**0.00508**	**0.00903**
2	**2.110**	**0.00908**	
3	**2.132**	**0.01292**	
4	2.120	0.00092	0.00164
5	2.121	0.00192	
6	2.117	0.00208	
7	2.117	0.00208	0.00142
8	2.118	0.00108	
9	2.118	0.00108	
10	2.125	0.00592	0.00697
11	2.126	0.00692	
12	2.111	0.00808	

Average Cell Voltage	2.119
Cell Voltage Standard Deviation	0.006317
Max. Cell Voltage Difference	0.022

Date: 11/19/90
Amp-hrs. -214
Amperes -2.1

Cell #	Cell Voltage	Absolute Cell V. Deviation	Average Battery V. Deviation
1	**2.083**	**0.00075**	**0.00758**
2	**2.078**	**0.00425**	
3	**2.100**	**0.01775**	
4	2.082	0.00025	0.00258
5	2.082	0.00025	
6	2.075	0.00725	
7	2.092	0.00975	0.00575
8	2.077	0.00525	
9	2.080	0.00225	
10	2.087	0.00475	0.00658
11	2.083	0.00075	
12	2.068	0.01425	

Average Cell Voltage	2.082
Cell Voltage Standard Deviation	0.008203
Max. Cell Voltage Difference	0.032

An alternative to the dump and refill method
The British motorcar publication recommended just adding the EDTA to the cells and that's all. We went into the dump and rinse madness on our own. Now, EDTA is supposed to work by just adding the compound to the cell. No draining, no rising and no electrolyte replacement. We are trying this technique with the remaining two sulphated L-16Ws and will publish the data when we get it.

How you can help…
This experiment seems to have worked. We would appreciate verification from anyone else who tries it. After all, if you are sitting on top of a heavily sulphated lead-acid pack, what do you have to lose? EDTA is cheap and it may restore lost electrical capacity to sulphated lead-acid cells. We would appreciate any feedback from those trying our dump and flush technique or those simply adding EDTA to the cells and just leaving it there. As a very general rule of

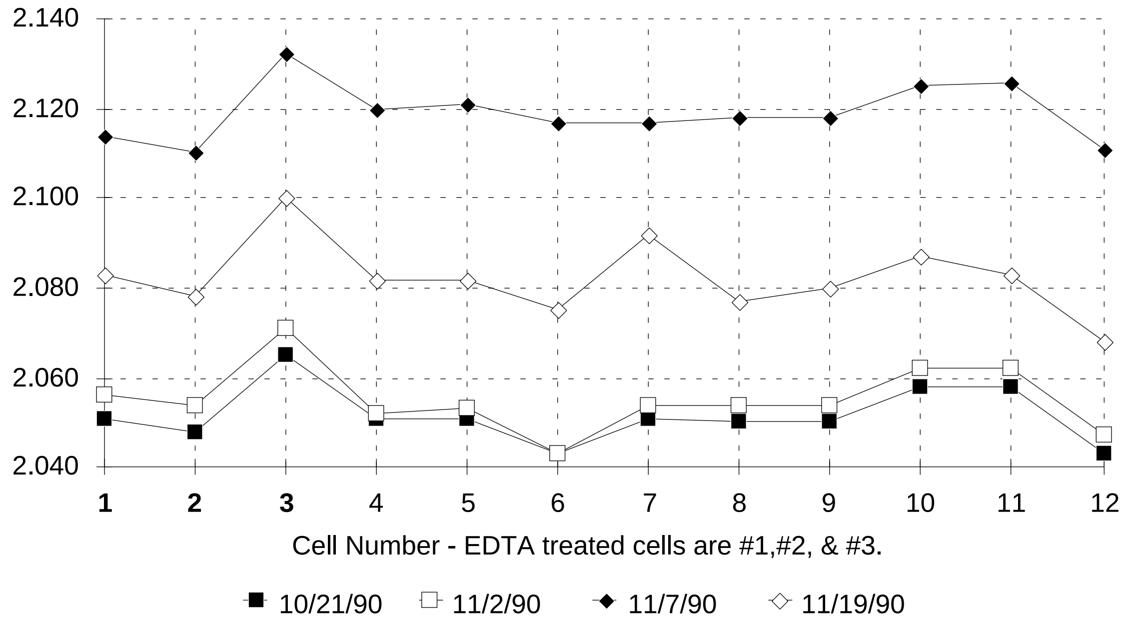
thumb, use 1 to 2 teaspoons of EDTA per 100 Ampere-hours of lead-acid cell rated capacity. EDTA can be ordered from any chemical supplier or from any aggressive drug store.

Conclusion

EDTA seems to work. I say again SEEMS to work. This experiment was far from scientific because it lacks enough cells to get a large statistical sample. Use of EDTA may extend the useful life of sulphated lead-acid cells by chemically stripping the sulphation from the plates' surfaces.

Really, the bottom line here is that I am sitting in front of this Mac, writing this article with electricity stored in lead-acid cells that before EDTA treatment were toxic junk. Color me amazed. And as a sidelight, the long and involved set of circumstances that led us to try this experiment is as amazing as the fact that it worked. Serendipity is an ingredient in this process.

Lead-Acid Cell Voltage Comparison on EDTA Treated Cells



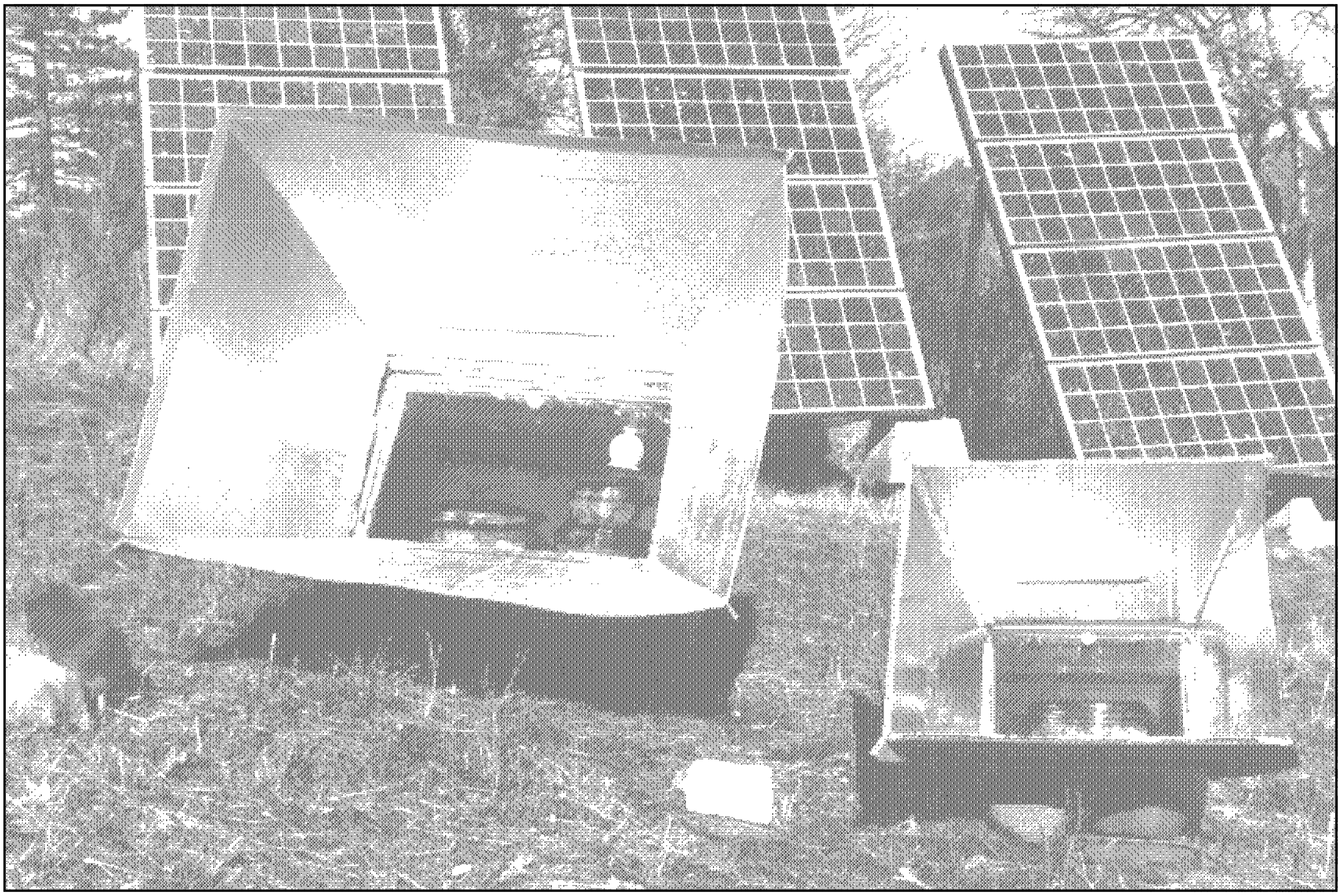
Access

Richard Perez, C/O Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179.

George Patterson, 3674 Greenhill Road, Santa Rosa, CA 95404.

Makers of the EDTA we used: Sigma Chemical Co., POB 14508, St. Louis, MO 63178 • 314-771-5750. Their stock number for EDTA is 48F-0104.

Suppliers of the EDTA we used: Vinquiry, 16003 Healdsburg Ave., Healdsburg, CA 95488 • 707-433-8869.



Two inexpensive, and very effective, solar cookers made from discarded cardboard boxes. Note the white hot mitt in front of the cookers. These are real ovens developing temperatures as high as 300°F. Without hot mitts, you will get burned.
Photo by Bob-O Schultze

Heaven's Flame Solar Cooker

Assembly and testing conducted by Kathleen Jarschke-Schultze

Having some experience with solar cooking, & eager to try more, I was excited by Joe Radabaugh's simple design. After seeing him demonstrate his solar cooker at SEER '90 I purchased his book, Heaven's Flame, and using it as a guide, assembled and tested a working solar oven.

Documentation

Joseph has spent the last 15 years designing and using solar ovens. His book, Heaven's Flame Solar Cookers, is easy to read and understand. What is even nicer is that it is interesting and informative. Seven chapters cover the topic thoroughly, including history, theory, design and tips on cooking. One complete chapter gives you detailed instructions on building the Heaven's Flame solar cooker. It is simple to make and simple to use. Joe encourages experimentation and modification to your personal preference and needs. There are some hints I have found out through my experience that I will share with you.

Cost and materials

So far the materials for the oven have cost me $3.37. I used anything that I already had on hand and that kept the cost way down. Had I bought everything I needed it still would have been under $10.00.

I already had a piece of glass, left by a previous tenant, that was double thickness (single thickness will do). I built my box to fit the glass, 14" x 22". This is larger than the model in the book, which allows me to use my regular cookware, a point I will discuss later.

Joseph's method of construction, using cardboard boxes, does involve some searching. In my correspondence with him, he mentions this as the most difficult part of assembly. Most stores crush their boxes and band them with metal straps in huge bundles, making them inaccessible. I have found that the produce dept. of large supermarkets is likely to have useable boxes if you ask to see them. Also, canned food outlets and some small convenience stores save their boxes. For the larger flat pieces, used for insulation and reflectors, I recommend trying furniture and appliance stores. Their dumpsters are a veritable wonderland of pristine cardboard, and many times it will be of a double thickness.

By using three nested cardboard boxes for the main body of the oven the construction is greatly simplified. You will probably use a whole roll of tin foil as it is used for insulation in the main body of the oven and as the shiny surface of the reflectors.

Because I live in a canyon, I experience varying degrees of wind every day. To help stabilize my solar cooker I used two sheets of double thickness glass (again on hand) and some silicone caulking to make a thermal pane (using a technique described in the book) to insulate and weight the bottom. Although it was not called for I also found that by gluing a small wooden knob onto the glass door I was able to open and close the hot glass much more easily. Following is a list of materials that I used. Those with an (*) asterisk are the things I bought, followed by their prices.

* 1 roll of aluminum foil $1.38
* 1 can flat black spray paint $1.99
3 nested cardboard boxes
4 flat pieces of cardboard for reflectors
Assorted flat pieces of cardboard for insulation
Elmer's glue
three panes of double thick glass
silicone caulking
razor (or sharp) knife
string
small paintbrush
small wooden knob
six metal spring clips

Cookware

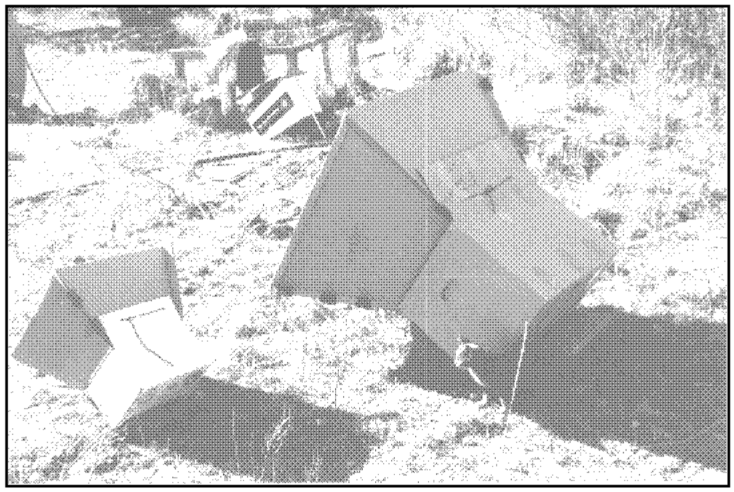
Although the book describes an effective method to use recycled jars as cooking vessels I prefer to use my own cookware. Joseph believes that when solar oven use is more wide spread a specific solar cookware will be developed and marketed. I believe it is here. I use the Corning 'Vision' cookware with excellent results. It is an amber colored material that allows you to see the food cooking, reducing the times you open the oven to check the food. Visionware also holds heat incredibly well, aiding the cooking process and keeping the cooked food hot longer. You can place the lid upside down in the pot and stack another on top of it to cook two dishes at the same time. There are also small casseroles available with flat lids that stack easily. In the photos you can see that I have three dishes cooking at the same time. The large casserole contains the main dish, the two smaller are the vegetable and dessert, respectively. I can throw together a quick salad and dinner is done. Clean up is a breeze because nothing ever burns in a solar cooker. Any black pot or pan with a lid works well, my favorites there are cast iron dutch ovens and 'Miracle Maid"cookware. When baking bread or cookies black or dark colored pans and sheets are the best.

One must always remember that this is a real oven. You need to have hot pads handy when you open your solar cooker to check or remove the food. Keep your face away from the glass door as you open it as the steam from some foods can burn you.

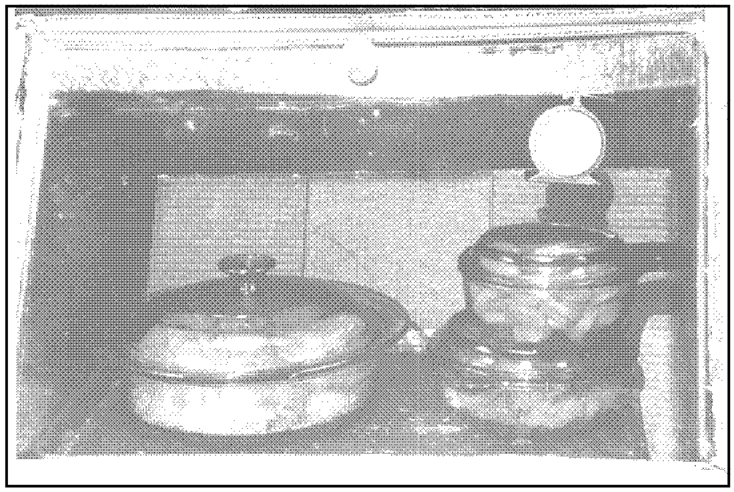
Kid-Sized Solar Cooker

The increased awareness about solar cooking in our house bore fruit. My husband brought me three small nested cardboard boxes and exclaimed, "Look, a Cabbage Patch solar oven!"

Having already made one oven using Joe's directions I didn't need to refer to them again. In one afternoon I had built a small working Heaven's Flame for my niece. It is big enough to cook a single serving size casserole, as you can see from the photo.



Above: a side view of both solar cookers showing their nested cardboard box construction. Photo by Bob-O Schultze.



Above: an inside view of the large cooker at work. Note the stacked cookware within the cooker. Photo by Bob-O Schultze.

Cons and Pros

The disadvantages of the Heaven's Flame solar cooker are few, but important to be aware of. Since it is constructed of cardboard, for the most part, it must be brought in at the first sign of wet weather. Even a heavy dew point will cause damage, as will setting it on wet ground. The oven itself is light in weight and must be weighted or watched in windy conditions. There is also a simple tie that can be utilized to secure the reflectors to the oven body. To position the oven at a correct angle I used short pieces of 6 x 6 lumber, although rocks or bricks could be used, wood was easier to move and adjust.

The lightness is a plus in that the oven is easily moved by removing and folding the reflectors flat and closing the outer flaps on the box. I used a box with handholds for the outer box to further simplify the task. The lack of cost and ease of construction makes this model oven available to everyone. By being able to choose the size of oven the utility will be suitably matched to your cooking needs.

Conclusion

You cannot fry food in solar cookers. The ovens never reach a high enough temperature, but just about any other recipe can be adapted for use. Recipes for crock pots need no adjustments. A rule of thumb for solar cooking is that it will take twice as long to cook the dish as in a regular oven. Vegetables cook in their own juice so there is no need for additional water. I have had great success with

beans, rice, spaghetti sauce, stews, & anything that likes long slow cooking. You can bake bread, muffins, bread and rice puddings.

What I really liked was being able to start dinner in the morning and not think about it again until dinner time. It was surprising to me how easily solar cooking fit into our lifestyle. It does take some planning early in the day but you are rewarded with a hassle free, hot dinner when you want it. My testing was conducted in the midst of firewood gathering and Autumn yard work when it came in very handy to have a hot meal waiting at the end of the day.

If you are interested in solar ovens but can't afford the manufactured model, I recommend building your own. Heaven's Flame is an easy, informative and affordable book that will get you cooking with the sun in a short time. Your personal experience will convince you of this cooking style's utility and fun.

Access
Joseph has a small supply of books left. He is rewriting more of his experiences into a revised edition yet to be published. The book is $5.00. You can get a shortened one page version containing the plans for the Heaven's Flame solar cooker by sending a S.A.S.E. and $1.00 to Joseph Radabaugh, POB 1392, Mt. Shasta, CA.

Heaven's Flame Solar Cooker
test data taken at Camp Creek, CA
41° 59' N. 122° 38' W. October 1990

Whole Chicken stuffed with Apples

Time	*Oven Temp. in °F.*	*Outside Temp. in °F.*	*Comments*
11:50	125	66	Setup oven, inserted chicken
12:20	200	67	
1:15	250	73	
3:10	300	74	apples & chicken browning
4:10	275	74	
4:50	200	72	Chicken done & juicy

Solar Tamale Pie

Time	*Oven Temp. in °F.*	*Outside Temp. in °F.*	*Comments*
10:30	56	56	set up oven
11:30	300	63	inserted large tamale pie
12:50	200	69	temp dropped - spilled pie
3:02	250	77	pie bubbling
5:00	200	64	pie done

Beef Stew and Garlic Bread

Time	*Oven Temp. in °F.*	*Outside Temp. in °F.*	*Comments*
10:30	≈80	≈80	inserted 8 pounds of stew
11:00	200	≈80	
2:10	260	≈80	loaf of garlic bread inserted
3:00	225	≈80	clouds move in
4:00	200	≈80	clouds gone
5:00	200	≈80	stew & garlic bread done

Recipes for Solar Ovens

Sunshine Chili by Bonnie Reynolds

1 lb. grnd chuck
2 med. onions
1 small green pepper
1/2 cup minced parsley
dash of salt and pepper
28 oz. canned tomatoes
1 lb. small red beans (dry)
1 TBSP. chili powder
4 cups V-8 juice

In your solar oven, brown ground chuck, onions, pepper, parsley and dash of salt and pepper. Drain well after about an hour, then add tomatoes, red beans, V-8 juice and chili powder. Bake covered about 4-5 hours; serves ten; you may add more V-8 juice as cooking proceeds.

Solar Lasagne by Karen Perez

Take a quart of spaghetti sauce and mix with 3/4 cup water. Take 1 pint of ricotta cheese and mix with 1 beaten egg. Chop one pound of fresh spinach or thaw two 8 oz. packages of frozen chopped spinach. Slice 1/2 lb. fresh mushrooms. Slice or grate 1 lb. Mozzarella cheese. Have ready 1 pound uncooked lasagne noodles and some Parmesan cheese.

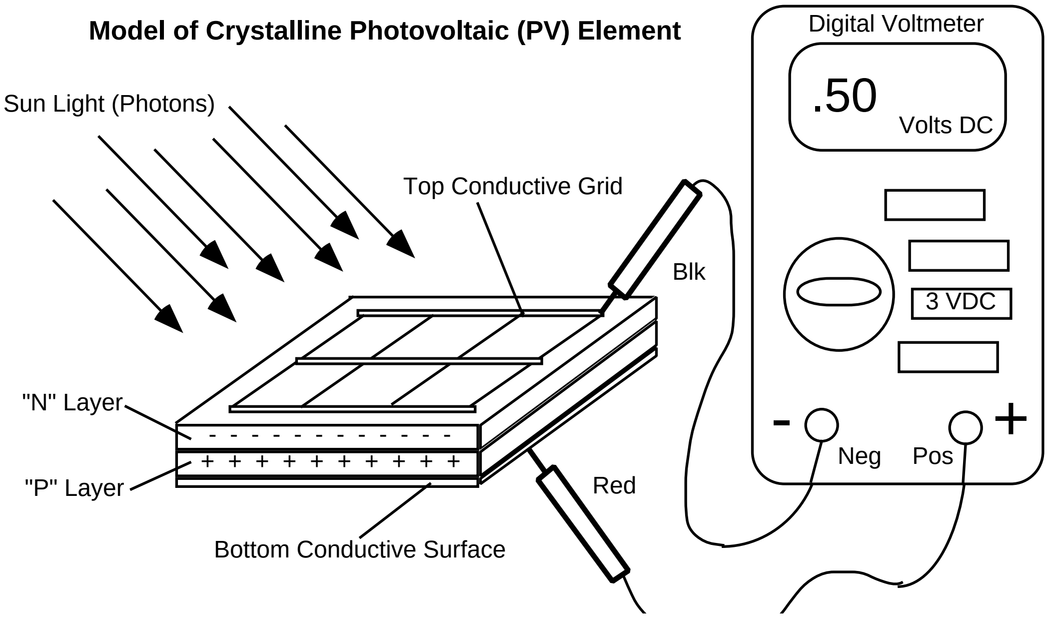
Spread some sauce on the bottom of a covered dutch oven, place a layer of uncooked noodles over that. Proceed to layer the rest of the ingredients alternately ending with sauce topped with the Parmesan cheese. Bake covered in a Dutch oven inside a solar oven about 2 1/2 hours. Makes six servings.

Photovoltaic (PV) Cell Model

Chuck Carpenter, W5USJ

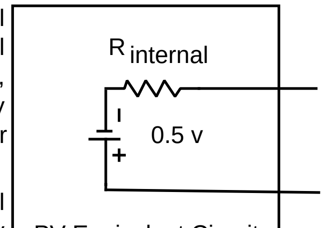
Photovoltaics are "sandwiches" of silicon, the second most abundant material in the world. One layer of silicon is treated with a substance to create an excess of electrons. This becomes the negative or "N" layer. The other layer is treated to create a deficiency of electrons, and becomes the positive or "P" layer. Assembled together with conductors, the arrangement becomes a light-sensitive NP Junction semiconductor. It's called a semiconductor, because, unlike a wire, the unit conducts in only one direction; from negative to positive.

Model of Crystalline Photovoltaic (PV) Element



An ideal PV is shown in the figure below. When exposed to sunlight (or other intense light source), the voltage is about 0.50 volts DC, and the potential current flow (amps) is proportional to the light energy (photons). In any PV, the voltage is nearly constant, and the current is proportional to the size of the PV and the intensity of the light.

Actual PVs, those available in the real world, are not as perfect as the ideal model. The equivalent circuit of a PV, shown in the diagram below, is a battery with a series internal resistance. (Similar to any other practical battery.)



PV Equivalent Circuit

Because of the variations in internal resistance, current and voltage will vary between cells of equivalent size & structure, connected to the same load, and under the same light source. Manufacturing techniques would strive for the lowest possible internal resistance. And, the variations in internal resistance are accounted for in the panel assemblies you buy.

Presently, there are two types of PV cells: crystalline, and amorphous. The crystalline units are the more common, generally blue-colored frosty looking ones. Amorphous means noncrystalline, and these look smooth and change color depending on the way you hold them. You see them now in solar-powered calculators and in some low-powered PV panels. Crystalline types are more efficient, but more expensive to manufacture.

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☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
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The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a subscription, but we would greatly appreciate this information so we may better serve you.

FOR OUR PURPOSES WE DEFINE ALTERNATIVE ENERGY AS ANY ELECTRICAL POWER NOT PRODUCED BY OR PURCHASED FROM A COMMERCIAL ELECTRIC UTILITY.

I NOW use alternative energy (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs)**

I want to use alternative energy in the FUTURE (check one that best applies).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs)**

My site has the following alternative energy potentials (check all that apply).

- ☐ **Photovoltaic power**
- ☐ **Water power**
- ☐ **Wind Power**
- ☐ **Other** ______________________________

HP#20

I now use OR plan to use the following alternative energy equipment (check all that apply).

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
☐	☐	**Battery Charger**	☐	☐	**Control systems**
☐	☐	**Instrumentation**	☐	☐	**PV Tracker**

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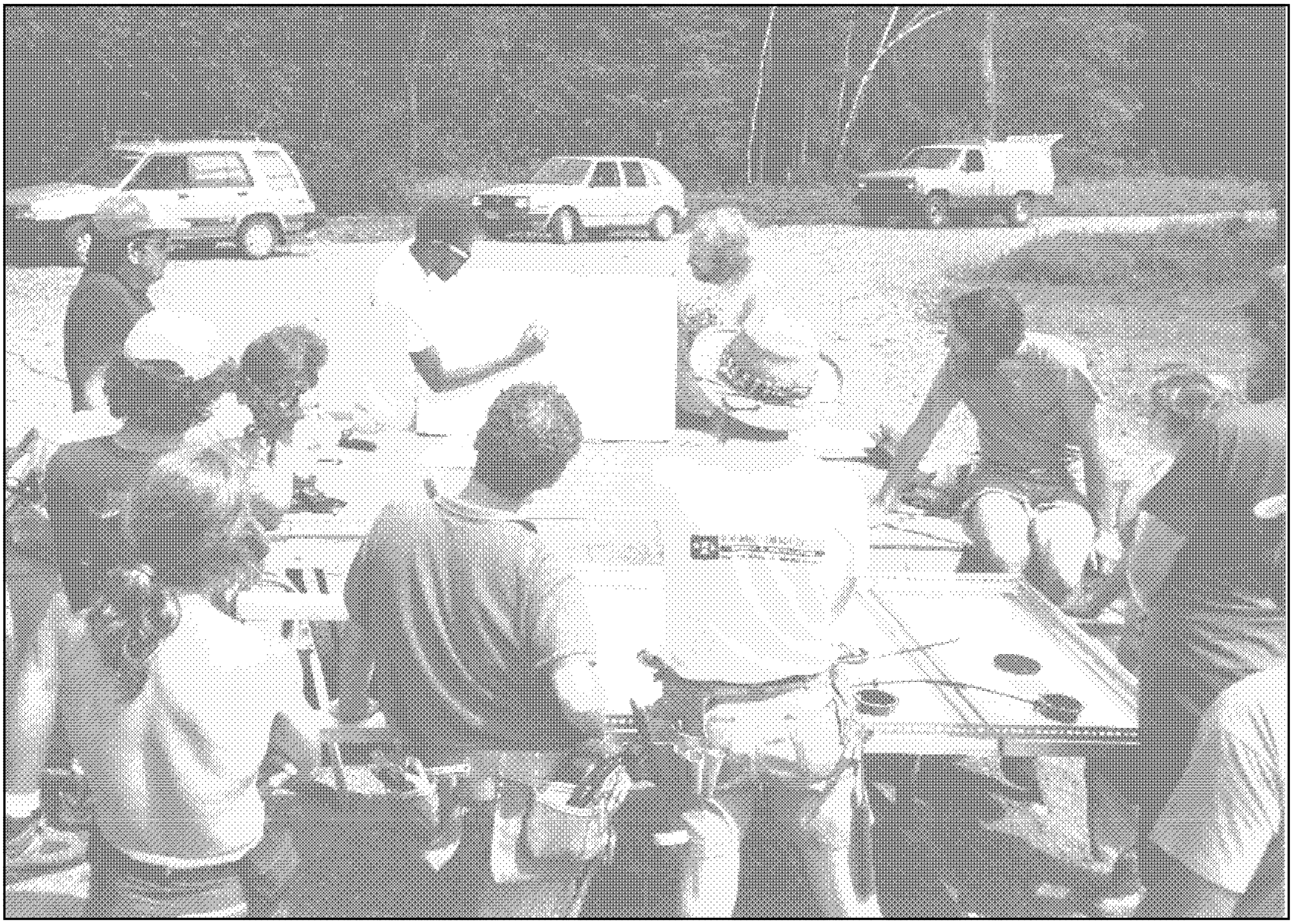

Above: Aubrey Marks and the ATA workshop crew get hands-on experience with photovoltaic system design and application.

NO SMOKE, NO FLAMES

PV powered health care in Guyana, South America

Aubrey Marks

Introduction by G.W. DeCelle

We met Aubrey Marks at the Appropriate Technology Associates (ATA) training seminar on June 1990 in Hyde Park, VT. Ken Olsen and Johnny Weiss were conducting this seminar at David Palumbo's Independent Power & Light. Ken had just returned after spending a year working with PV-powered health centers in Central and South America. He helped us understand the vital significance of Aubrey's work throughout his homeland of Guyana.

Aubrey Marks is no stranger to travel. This thin, quiet and unassuming man is probably one of the few persons living anywhere to have installed over 1,000 solar modules worldwide. He is now solely responsible for maintaining Guyana's thirteen PV systems. They are scattered throughout 83,000 square miles of Guyana (about the size of Idaho). Each of these critical systems powers vaccine refrigerators, hospital lighting or medical equipment. Aubrey is committed to PV-powered health care and maintenance in his home country. He provides expert care and maintenance despite little funding for worn out or defunct parts, including batteries.

After a two day 44 mile maintenance walk through the bush of Guyana, carrying all necessities on his back, Aubrey arrived home in Georgetown to find a letter from the Pan American Health Organization (PAHO), a division of the World Health Organization (WHO). They were notifying him that they would sponsor him to attend the ATA workshop being held in Vermont within a week.

In ATA's workshop he worked quickly and precisely - ***"no smoke, no flames"****. At the end of a long and busy day, when fellow students couldn't quite get all those wires to fit into the disconnect box, Aubrey patiently and neatly put it all together. It was an added privilege for us all to have worked alongside Aubrey.*

G.W. DeCelle.

NO SMOKE, NO FLAMES

Aubrey Marks

I am grateful to the World Health Organization for the opportunity to participate in the PV design and installation program mentioned earlier. Many people participated who had no technical knowledge of PV systems, but at the end of the workshop they were designing and had actually installed three PV systems. Two of these systems were powering private homes in the lovely Vermont countryside.

From February to June 1982, U.S. AID sent me to attend the Alternative Energy Training Program at the University of Florida. This provided the background for helping to install two systems in Guyana. I also installed two systems in Kenya, one system in Ecuador, and one system in Zimbabwe during 1983.

PV in Guyana

Many scattered communities are in the outback of Guyana. The health sector has started to provide lights, refrigeration, sterilization and water supply to hospitals and health stations to remote areas. Because of PV, the vaccination program has been more effective and more children are being protected from many diseases which easily attack them from birth. Following are some of the major PV installations in my country.

SCHEPMOED: This PV powered refrigerator/freezer, with 8 modules, was the first system to be installed at the Schepmoed Health Station in September 1982. It was installed by ARCO engineers, but the person who operated the system did not stay around very long. The system has suffered because it was left unattended for such a long time until I came along to begin maintenance on it.

WARAMURI: In January 1983, Development Sciences Inc. of Massachuetts went to Guyana to install a U.S. AID system. This system has 55 modules which are connected to 20 C&D 250 Amp Hour, 6 Volt batteries for a total system voltage of 120 Volt DC. There is no inverter and the lights and sterilizer are rated at 120 VDC. A DC to DC converter provides 12 Volt DC for the refrigerator/freezer and the radio. This system has worked for the last 7 1/2 years, but we expect battery failure in the near future. We have reduced the lighting loads and disconnected five modules because of the batteries being in such poor condition.

SAND - CREEK: In the southern Savannahs we installed an 88 module PV system in June 1984 which has 9, 12 Volt, 500 Amp Hour Exide batteries to power the Health Station through a 240 Volt AC inverter. During the last two years, I found that the batteries required equalization charging more regularly. I visit this system three times a year for preventative maintenance and equalization. Equalization must be accomplished by using power from the PV panel. This method requires over a week of normal sun and sometimes I must leave before the week is up. In that case I instruct the staff on its completion.

KUMAKA: During August 1984, we installed the largest PV system in Guyana at the Kumaka District Hospital. It has 506 modules and 36, 6 Volt, 1500 Amp-Hour Exide batteries and two 8 KVA 120 Volt DC to 120 /240 Volt AC inverters. Damages occurred after two months of operation because the shutdown sequence was not adhered to. Apparently the battery switch was opened and under full sun the high voltage damaged the inverters. An attempt is being made to rehabilitate this system in 1990.

ORALLA: In April 1985 an 88 module PV system was installed at the Oralla Health Clinic. This system has the only cold storage health facility on the Corentyne River. It has 9, 12 Volt, 500 Amp Hour batteries which provide power through a 2 KVA, 120 Volt DC to 240 Volt AC inverter.

MABARUMA: Another 88 module system is installed at the Mabaruma Hospital in August 1985. This system has 9, 12 Volt, 500 Amp-Hour Exide batteries and a 2Kva inverter providing only lighting. Three other small stand alone systems were installed in 1985 in Mabaruma by a person other than myself, but the systems in Guyana are being maintained by me at the present time. Those systems are: 1. A Sunfrost double door freezer that works on the upper section only because the original batteries were replaced by a smaller size, thus reducing the amount of energy available. This will be rectified soon. 2. A Sunfrost single door vaccine freezer chest had it's batteries replaced in January 1989 and has been working very well over the past 18 months. 3. A stand alone water pump was also installed at the hospital in 1985. This unit is out of operation presently, but the batteries will soon be replaced.

LOND CREEK: WHO/PAHO presented a PV powered refrigerator/freezer to the Ministry of Health in Guyana during 1985. This system was completely rehabilitated in February 1990 under the guidance of Steve McCarney (now Regional Manager of Photocomm in San Juan, Puerto Rico). We replace the batteries, controller, thermostats and the power and control cables. It has worked well over the last 8 months and has 8 modules, 2, 12 Volt, 200 Amp Hour batteries and a Polar Products freezer.

MAHDIA: Another WHO/PAHO PV powered refrigerator/freezer was installed at the Mahdia Hospital in 1986. The system has 6 modules but the batteries will soon be replaced because the present set are shot.

LETHEM: WHO/PAHO provided a PV power refrigerator/freezer at the Lethem Hospital in November 1988 where utility power is available for only 5 hours a day. This systems has 5 modules and 4 sealed batteries which solely power the refrigerator/freezer.

AISHALTON: This system is similar to the one installed at the Lethem Hospital. Installed in December 1988 it is the hardest to maintain because of its location. You must travel 1.5 hours by air and 150 miles by road. In the rainy season the road trip becomes impossible.

KAMARANG: This PV system was also provided by WHO/PAHO. It is similar to the two above systems and was installed in March 1989. In March 1990 we added a 12 Volt DC light for the technician to use in the Malaria laboratory.

PV Maintenance

With limited spare parts we have a planned maintenance program which provides for a visit at 4 month intervals to all locations except Kumaka. They are on a 3 month schedule, but is actually doubled because the battery is on charge without a controller.

Most of the installations are located in areas where boats, trucks or aircraft are the only means of transportation. Sometimes these trips also involve a long walk because of high rivers which make vehicle travel impractical. Most of the area have crocodiles, malaria carrying mosquitos, snakes and other animals, but we do our work with maximum precautions.

Access

Author: Aubrey Marks, A.J. Marks and Associates, POB 10844, Georgetown, GUYANA.

For information on the PV Training for Global Energy Health contact Appropriate Technology Associates (ATA) at 410 Garfield Ave, Carbondale, CO. 81623 • 303-963-2682. See HP17 and HP13 for more info.

The Price of Power

K.W. Landis, P.E.

In the fall of 1988, I designed and installed a small PV system for my home in Kansas. My intent was to use a simple stand alone system to gain experience in home power generation and solar energy. It would be a way to increase the awareness of solar power in my community. The two most asked questions about my PV system are: 1) does it work? 2) do you save any money?

Does it Work?

The answer to the first question is easy, yes it works. It works very well. I can use solar energy to light my home (halogen and fluorescent), provide entertainment (stereo, TV, VCR), cook food (crock pot), recharge power tools, and many more functions. Furthermore, I can do these things without burning fossil fuels, strip mining coal, or creating nuclear waste or acid rain. The answer to the second question has been less definitive. I'd usually say "no, it costs more, but that's not why I did it." Then I'd repeat the answer to the first question. This article presents several ways to calculate the cost of solar energy.

PV System Cost

The total cost of the PV system is calculated here assuming an economic life of 20 years and an interest rate of 8%. The cost to replace my golf cart type batteries every five years is included. The 50 $/year maintenance cost includes lamps, fuses, and miscellaneous expenses. All costs are converted to their present worth at the time of system installation. The annual owning and operating cost is then found by calculating the Equivalent Uniform Annual Cost:

EUAC = 3100 (0.08) / [1-(1.08)-20] = $316 /year.

PV ENERGY PRODUCTION

To find the maximum amount of energy the PV modules could produce at my location, I followed the method in reference 1. This method involves calculating the total isolation on the tilted array on the average day of each month. Then multiplying by the days in each month to get the actual monthly insolation in WH/m2 month. The output of the PV modules is rated by the manufacturer at a specific rate of insolation. My ARCO M55 modules are rated for 53 Watt output at 1000 W/m2 insolation. The monthly rated insolation is then: (actual insolation/ rated insolation) X rated output. The maximum energy output is rated for each month and added up for the annual total. By this procedure I arrived at a maximum generating capacity of 379 KWH/year.

The cost of generating solar electricity is the equivalent annual cost of the PV system divided by the annual output: 316/ 379 = 0.83 $/KWH. If this price is to be compared to utility rates, then the system cost should not include wiring, lights, and other costs that would also be incurred in using utility power. The EUAC for the PV production equipment only is estimated at 235 $/year. Therefore the cost to produce solar electricity is: 235 / 379 = $0.62 /KWH.

While these are interesting numbers I wasn't sure either was the number I was looking for. For one thing I am not using all the energy my system can deliver.

ENERGY CONSUMPTION

Since my consumption of solar energy is not metered I don't know exactly how much energy is used. However, my home is also supplied by the electric utility. Consumption of utility power during the 18 months from January 1987 through June 1988, before the PV system was installed, averaged 2652 KWH/year. Since I had made no other significant lifestyle changes, I can assume that the solar system saved 2652 - 1562 = 1090 KWH/year. The cost to save energy then is: 2.7 times the maximum output capacity of the PV array, even though the PV system is not used to its capacity.

Another way to look at these numbers is to say that I am now using some amount of lighting, entertainment, tools, etc. equal to my original consumption of 2652 KWH/year. My total cost now is the equivalent annual PV cost plus my payments to the utility (utility payments include service charge). Therefore: the cost to provide an equal standard of living with the combined systems is:

(316+ 163) / 2652 = 0.18 $/KWH.

ENERGY EFFICIENCY

The saving vs. production discrepancy comes from differences in the efficiency with which we use PV electricity and utility electricity. The costs of installing a PV system often include new high efficiency appliances. In my case the increase in efficiency primarily comes from lighting. When an inefficient appliance is replaced by an efficient appliance it is said that the new appliance "saves energy". It is also accurate to say that the new appliance "generates" energy equal to the amount "saved".

For example if a 75 Watt incandescent light is replaced by an 18 Watt compact fluorescent, the new bulb can be said to "save" or "generate" 75-18 =57W or 0.057 KWH/Hour. If used for about four hours per day the fluorescent bulb will have an amortized cost around 4 $/year and "generate" 83.2 KWH/year. Therefore, this light bulb can "generate" electricity for: 4 / 83.2 = 0.048 $/KWH. Note that this figure depends on the cost and usage rate of the bulb, but does not depend on the price of energy consumed by the bulb.

We can conclude that the combined costs of generating electricity through more efficient appliances plus PVs can be much lower than the cost of PVs alone. The cost per KWH however, can vary widely with the choice of included costs and methods of calculation.

SOLAR POWER

My PV system saves an average of 77 $/year off my utility bill, but it costs me 316 $/year to do it. In other words I'm paying twice as much per year as I would using utility power only. My PVs save something far more important than money though. Because I use less energy from the utility, they save 2600 pounds of carbon dioxide pollution per year. They save over 7 pounds of sulfur dioxide pollution per year. They save over 900 pounds of coal per year and maybe a small piece of Wyoming hillside. That's what solar power is all about for me. The power to make a difference in the world. The power of choice. The power to help create a cleaner more healthy place to live. Solar energy may be expensive but solar power is priceless.

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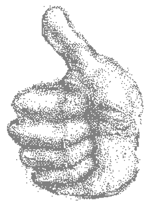
1. Duffie, J.A., W.A. Beckman. Solar Engineering of Thermal Processes. John Wiley & Sons. 1980

2. Knapp, C.L., et al. Insolation Data Manual. Solar Energy Research Institute. 1980

3. Leckie, Jim, et al. More Other Homes and Garbage. Sierra Club Books. 1981

ACCESS

Kevin W Landis PE, 160 W. Main, Kipp KS 67401-9065.



Things that Work!

Ample Power Company's Energy Monitor

Testing conducted by Bob-O Schultze-KG6MM

It's an old saw in baseball that "you can't tell the players without a scorecard." In battery-based Renewable Energy systems, it's just as hard to tell at a glance whatcha got under them battery caps without an Amp-Hour meter. Ample Power's new Energy Monitor not only gives you a running numerical total of the Ampere-Hours into and out of the battery, but throws in a highly accurate digital voltmeter and ammeter to boot.

The Energy Monitor

Ample Power's Energy Monitor (or EMON) is basically a microcomputer instrumentation system which provides all the essential information required to manage your RE system's battery bank. It consists of a heavy duty shunt and the Display and Processing Unit (DPU) which processes the measured data and shows the information on a large (1/2"), well backlit, LCD display. The DPU has two switches on its 4.75" X 4.75" flush mounted front panel. One of the switches turns the backlighting on or off (a watt saved is a watt earned), and the other toggles between Volts, Amps, and Ampere-Hours. The Ampere-Hour function records up to 1,999 A-hr, and with a full scale voltmeter reading of 32 volts and a full scale ampere reading of 400 Amps, the EMON is equally at home in either 12 or 24 VDC systems.

Packaging and Documentation

The EMON arrived in fine shape shipped via UPS Brown at this location packaged in an oversized box with plenty of insulating material. The docs were thorough and complete with hook-up diagrams and enough well-written information to satisfy both the average user and all you techies out there.

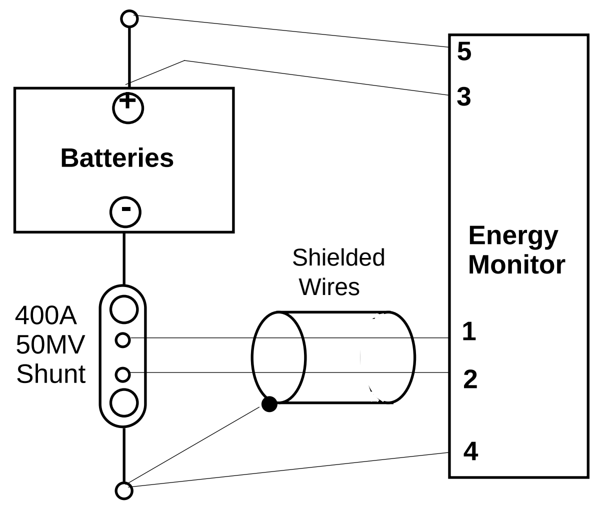
Test Environment

We installed the EMON in a Home Power test system consisting of 8 Kyocera K-51 PVs, a Heliotrope CC-60B charge controller, Trace 2012 SB inverter, and 440 Ampere-Hours of reconditioned Nicad pocket-plate batteries. Additional charging was provided using a 3.5 kW. gasoline generator. All EMON measurements were compared against two Fluke 87 DMMs.

Installation

The Energy Monitor is designed to be flush mounted. Since I had a handy uninsulated wall within reasonable proximity of the battery bank, I followed the instructions, cut out a 4" square hole, ran the hook-up wires thru the hole, made the connections, and set it in. If I had it to do over again, I'd buy some extra wire and mount the EMON in the living room. It's a very good looking unit. The Energy Monitor is connected to the world via five wires. One goes to the negative distribution side of the provided shunt, two to the "+" side of the battery (sensing and backlight power), and two to the shunt itself. A word about this shunt... I'm very leery of putting anything between a battery terminal and an inverter. A fairly small amount of resistance in inverter cables can mean the difference between an inverter starting a high starting surge appliance or not. The folks at Ample Power recognize this and provide a gonzo 400 Ampere, 50 mV. bruiser of a shunt made by Empro and rated at 0.25% accuracy. I'm impressed.

The manual recommends twisting the two shunt sensing wires together to reduce noise and transients on the lines. Where radio transmitting is happening or where the wires pass in proximity to large fluorescent lighting, shielded, twisted sense wires are required. Being a Ham Radio kinda guy with a house full of fluorescent lighting, I went for the shielding. Ample Power sells this shielded wire for \$.50 per ft., or you can find 30 feet of Part #278-777 for \$7.95 at your local Radio Shack.

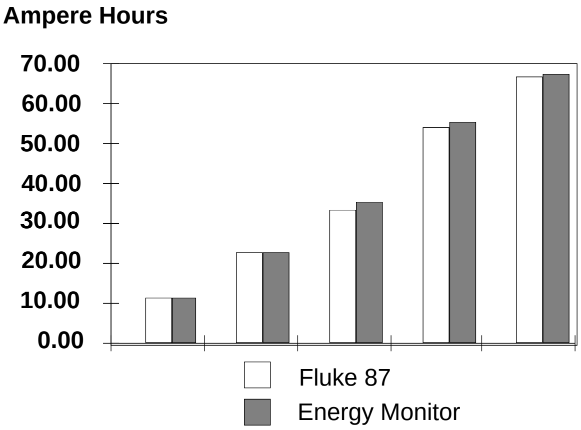


Operation

User operation is simple. The switch on the left turns the backlight on or off. So much for that. When the right hand switch is in the down position, the display shows Ampere Hours. A negative number shows cumulative discharge from the battery and a positive one indicates recharging past the zero point. When the EMON senses a battery voltage of 14.2 V in a lead-acid system or 15.5 V in a Nicad systems, it resets the Ampere Hour function to zero after the charging cycle ends. With the switch in the up position, the display shows either volts or amps. Toggling the switch back down then up again displays the other function. The Ammeter shows net current flow to or from the battery. For example, if your PV array was putting out 12 Amps and your usage load was 8 Amps, the meter would read "4", indicating that 4 Amps were flowing into the batteries.

Performance

The test data shown by the chart was taken over a 5 hour period one evening. Typical energy uses were for lighting, TV, VCR, and a big Macintosh computer. The variances between the Ampere-hour discharge figure recorded by the EMON and the 2 Fluke 87s were so small that they don't even count in Home Power systems.



Voltage and current measurements varied by ±0.25%. Close 'Nuff!

Cost

Ample Power Company's Energy Monitor costs $299.00. It comes complete with its own gonzo heavy-duty 400 Ampere low insertion loss shunt and a good set of instructions. Order #2020 for lead-acid or #2020N for nicad battery systems.

Conclusions

The Energy Monitor is a highly accurate instrument for measuring your battery's state of charge. It features the best shunt used on any ampere-hour meter in the Home Power market today. It's a voltmeter and an ammeter into the bargain. I like it. I like it a lot. It's a "Thing that Works!".

Access

Author, Bob-O Schultze, Electron Connection, POB 442, Medford, OR 97501 • 916-475-3401.

Maker: Ample Power Company, 1150 N.W. 52nd Ave., Seattle, WA 98107 • 800-541-7789 or 206-789-5758.

Skyline
Engineering
AD

The Whisper 1000 Wind Powered Generator

Mick Sagrillo

Being in the business of repairing wind generators, I've seen a lot of junk come through the door. We witnessed the "rebirth" of the wind industry in the late 1970s with about 80 wind generator companies setting up shop. Virtually all of these companies, which produced anywhere from a handful to a few hundred mostly Rube Goldberg units each, have gone bankrupt. About six have survived the shakedown. Needless to say, I'm quite skeptical when I hear of a new wind generator design.

Simplicity

About a year ago, I talked to Elliot Bayly of World Power Technologies about the new design he was developing. Bayly has been in the business of manufacturing wind generators for 13 years. He is one of the survivors that I mentioned. I got the lowdown from him on his new machine and decided it was worth my while to pay him a visit. Last winter, I saw what I believe is the simplest wind generator design ever developed.

My definition of simplicity is related to the number of moving parts a machine has. The greater the number of moving parts, the more maintenance is involved. Bayly's design, which is a spin-off of the very successful 1930's Paris-Dunn wind generator, has only three moving parts: the rotor, the yaw. and the tilt-up governor. This, folks, is a record!

The Design

The Whisper 1000 is driven by a two-blade rotor, nine feet in diameter. The rotor drives a brushless permanent magnet alternator of your voltage choice. The yaw, which allows the wind generator to track the wind, clamps to a 2" pipe. But the governing mechanism, traditionally the most wear-prone component of any wind generator, is what separates the Whisper 1000 from all the rest. The Paris-Dunn design is governed by tilting the rotor up and therefore out of the wind. There are several wind generators on the market today utilizing this simple governing technique. But the Whisper 1000 accomplishes this by using the tail as the tilting counterweight. In other words, the rotor tilts up while the tail tilts down. No springs (or bunji cords) and no hydraulic or air cylinders that will eventually wear out and need replacing. Tower-top weight for the system is 55 pounds.

Wonder Windings

Bayly, who holds a PhD in electrical engineering, has after three years of experimentation, come up with an alternator that is remarkably versatile. This is not an alternator built for one application that has been reworked to serve as a wind generator. The alternator was designed by Bayly and built by World Power Technologies to match the power output of the rotor. The Whisper 1000 comes with either a low voltage winding, factory connected for 12, 24, 32 to 36, or 48 volts, or a high voltage winding, factory connected for 60 to 72, 120, or 240 volts. The versatility comes from the fact that the owner can reconnect the wires of either model for any voltage desired in the alternator voltage group. This means that if you purchase a 12 volt model and later decide to switch to a higher battery voltage, say 24 or 36 volts, you simply reconnect the wires in the alternator junction box for the voltage you want and "presto!", you have an alternator with the desired voltage output. This is the only alternator on the market that offers this feature. No longer do you need to purchase a complete new wind generator to upgrade your system.

The Manual

The Whisper 1000 comes with a very complete owners/installation manual. Besides the usual installation and maintenance instructions, the manual also covers troubleshooting, wire sizing charts for different voltages, battery sizing, and the above mentioned wiring diagrams for changing alternator voltages. A real bonus is a section on the design and construction of a tilt-up type tower up to 100' in height for the Whisper 1000. The design is for a guyed tower made of locally available parts and well casing or pipe.

Controls

The control box is simple, consisting of a 3-phase bridge rectifier to convert the alternator output to DC, and a switch to shut the machine off. This is known as dynamic braking and occurs by shorting the three phases of the alternator together. As a result, you can shut the Whisper 1000 down with the flick of a switch from the comfort of your home. No more running out to the tower in the middle of a thunderstorm at night! The only down side I found to the whole system is that there is no way to trickle charge your batteries with this controller. However, by adding any shunt-type PV regulator of adequate current-carrying capacity, batteries can be taper charged.

Water Works and Heat, Too!

With the addition of an optional control package, the Whisper 1000 can be used to pump water or for resistive heating loads. Water pumping is accomplished by incorporating a readily available 3-phase motor into the system. As the wind speed increases and decreases, the 3-phase motor will act as as variable speed pump.

Power Output

The factory specifications for current output (in amps) and the power curve of the Whisper 1000 are as follows:

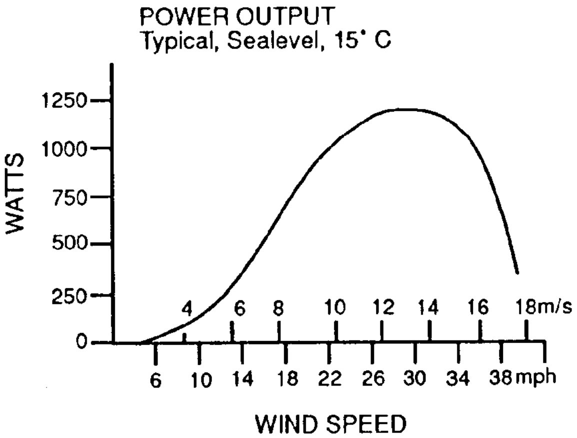
RELIABILITY

I am often asked about the reliability of a wind generator, if it will last through the ages (or at least through a few storms). Based on the simplicity of this design and feedback I have gotten from satisfied customers, I would recommend the Whisper 1000 to anyone looking for small-scale wind. But realize that the Whisper

Whisper 1000 Wind Powered Generator

Battery Voltage	*Amps at* ***13.5*** *mph*	*Amps at* ***18*** *mph*	*Amps at* ***22.5*** *mph*	*Amps at* ***27*** *mph*
12	18	41	65	72
24	11	24	35	39
32	9	20	32	37
48	6	12	20	23
120	2.5	5	8	9

1000 has been commercially available for only 1990 and does not have a track record. With a year-end production of 80 units (20 sold in the USA), Elliot Bayly confided in me that he has had only one part failure, and that appears to be the result of the customer over-torquing some bolts. That's an excellent track record.



Final Notes

The cost of the Whisper 1000 with controller is $1290, plus shipping. It is shipped via UPS in two boxes. The Whisper 1000 comes with a full two year warranty covering materials and workmanship. Delivery is now 60 days from time of order.

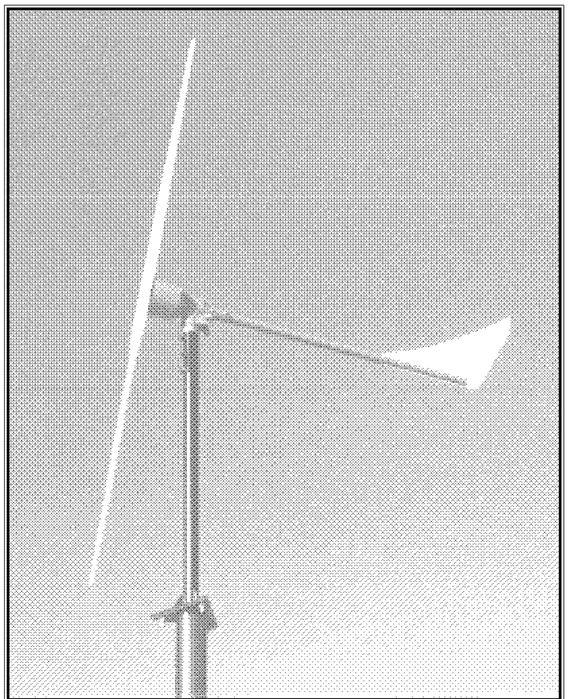
Whisper 1000 Specifications

Rated Power (11.2m/s, 25 mph)	1000 watts (1kw)	
Peak Power	1.1 to 1.4 kw	
RPM at Rated Power	730	
Start Generating Wind Speed	2-3 m/s	5-7 mph
Survival Wind Speed	55 m/s	120 mph
Propeller Diameter	2.7 m	9 ft
Blade Tip to Tower Clearance	35 cm	14 in
Tower Top Weight	25 kg	55 lbs
Lateral Thrust	1100 n	250 lbs
Ship Weight (UPS shippable)	32 kg	70 lbs
Shipping Volume	0.1 cu m	4 cu ft

Access

Author: Mick Sagrillo is owner of Lake Michigan Wind & Sun, E 3971 Bluebird Rd., Forestville, WI 54213 • 414-837-2267.

The Whisper 1000 is available from most wind generator dealers.



COMPUTING ON 25 WATTS

John C. Osborne

The first electronic computer, ENIAC, ran on 174,000 Watts of electricity. Today's desktop systems need 700 times less. As a home power user, you can do 10 times better yet by building your own computer. This column tells how to build a computer drawing about 25 Watts.

BUILD A COMPUTER? ARE YOU KIDDING?

No, computer stores do it all the time. All the parts are available from hundreds of suppliers as commodity items. Monitors, printers and keyboards simply plug into the system box. Inside are a few subassemblies installed with just a screw driver.

SCOPE

These items are needed for a minimally functional system. 12 Volt DC input is assumed, but other DC voltages are practical, also. Scanners, printers, modems, FAXs and other fun stuff are not the subject of this article. This discussion is limited to IBM clones because they are the most common and offer the largest choice of parts.

STRATEGIES

There are three main ways to achieve operation from 12 Volts. A fourth method is a combination of the others.

Use an inverter

The most common and obvious method, but also the least efficient at 400-600 watts. If you already have an inverter, this is the cheapest from the standpoint of initial cost, but the ongoing operating cost is the highest.

Exchange the power supply

A few minutes with a screwdriver and your old PC power supply can be replaced with a high efficiency 12 VDC unit. This has moderately low initial cost if you already have a computer and ongoing costs are reduced. You still have the problem of running your monitor and printer, however.

Select and modify components

By researching the hundreds of available parts, it is possible to find some with very low power consumption. Some can be modified for further gains. For instance: when a monitor rated at 42 Watts at 120 VAC was converted to 12VDC, it needed just 12 Watts. The "select and modify" strategy is the only way to approach our 25 Watt goal. It may be the cheapest overall cost as well. No inverter is needed, the power supply is small and only the very smallest of home power systems would need expansion to carry the extra load.

Use a hybrid approach

Run the items that are used for long periods (the computer and monitor) from 12 Volts and those devices used occasionally (printers & scanners) from an inverter. This way, you get many of the benefits without undue effort.

ITEM BY ITEM ADVICE

Lets examine the pieces needed for the "selection and modification" approach. I will give the typical Wattage, the percentage of the total, and some alternatives for dramatically lowering the Wattage. Things get a little technical from here on but if the guts of a computer put you off, let someone build the computer to your specs.

Monitor

This is usually the worst single item at 40 to 200 Watts or as high as 40% of the total. Color, screen size and resolution eat up the power. Staying with a conventional CRT monitor is cheapest, but a 12 Volt, B&W, 12" screen at 640 x 200 resolution takes the power down to just 12 Watts. A 12 inch, B&W, 640 x 480 is 25 Watts and a 12", color, 640 x 480 is 35 Watts. More demanding users can choose LCD screens at about 3 Watts, but about 5 times the cost. For the radical among you, a head mounted device that rests in front of one eye floats a 12" image about 18" in front of you. Its like the Head Up Displays in fighter jets. It uses one third of one Watt.

Motherboard

The motherboard characterizes the entire system. It uses from 20 to 50 Watts typically, or about 10% of the total. This is far lower than the monitor, but when we get the monitor down to 12 Watts, the it's draw becomes more significant. Some new boards are down to 7 Watts. Look for boards called "baby AT" size. Since more functions are forced into fewer chips to fit the smaller boards, designers have to reduce heat buildup and therefore the power is lower. Short of checking the specs, fewer chips normally means lower power. For the very lowest power (3 Watts and under) special purpose industrial grade boards are available, but at 3 times the cost.

Disk drives

Hard and floppy disk drives often use 20 to 40 Watts, another 10% of the total. But newer floppy drives need only 2 Watts when running and 1 thousandth of that when idle. The only floppy drive to consider are the 3 1/2" style. The older 5 1/4" need 5 Watts running and 1.5 Watts even when idle. Also, they are less reliable and lower capacity. For entry level computers, two 3 1/2" drives at 1.44 MB each may obviate the need for a hard drive. For those applications that need them, 40 MB units drawing only 4 Watts are quite affordable. I recommend the IDE (Integrated Drive Electronics) interface. This means the disk controller is built into the drive. While it raises the cost of the drive, it lowers power consumption, increases performance and makes installation much easier than previous generation drives. For extremists, drives drawing a mere .9 Watts are available at twice the cost.

Plug-in cards

Multiple plug in cards use 20 to 60 Watts, or 12% of the total. Some are necessary for the computer to function, like video, floppy disk, hard disk, printer and serial controllers. Other cards are accessories, like modems and FAX cards. To reduce power consumption here, find cards that combine as many functions as possible on the same card. As with the motherboard, packing more functions into a smaller space means using denser chips, forcing the designer to limit the heat and therefore the power. This strategy can save money and open slots in the motherboard.

Power supply

It's odd to think of a power supply using power - it's job is to convert it. But the process may consume up to half the power sent to the computer boards. This could be 140 Watts or 30% of total power consumption. A common perception is that switching type power

supplies in PCs are efficient. While they certainly could be, they are often designed to be cheap to buy, not cheap to operate. Converting everything inside the case to 12 Volts is a simple matter of dropping in a power supply that takes 12 Volts as input. Because power consumption matters to us, power supplies for this purpose are often 70 to 80% efficient. As we have seen, however, we need far less power than normal PCs and this offers new opportunities. For example, it is possible to run from a single 5 Volt supply by using floppy drives only, no serial ports and no accessory cards that might need other voltages. Since the power drain can be low, a simple 5-Volt regulator chip available from most electronics stores can form the complete power supply.

For those needing multiple voltages, power supplies normally used in laptop computers can be used. These provide only 25 to 50 Watts and while they would be hopelessly overloaded by typical PC parts, our specially selected units work fine. Making your own 5 Volt regulator or using the laptop supply require some experience with electronics.

PUTTING IT ALL TOGETHER

A few more pieces are needed. The keyboard simply plugs into a connector on the motherboard and doesn't draw enough power to worry about. You may need cables for disk drives, though they often come with the controllers. Mounting kits are needed for adapting 3 1/2" drives to fit the 5 1/4" spaces. The case can be the smaller size "XT" case if a baby motherboard is used. Don't try to do without a regular case. It provides grounding and shielding. The shielding works both ways - preventing the computer from radiating interference to radio and TV receivers and also prevent outside noise from reaching the computer. I often find that a monitor's high voltage supply is picked up by the disk drive unless the case is closed. The last "piece" is software - you need an operating system, usually DOS.

Starter system

A good 25 Watt system for the newcomer to computing consists of an "XT" motherboard with 640 KB of memory, dual high capacity floppy disks, a 640 x 200 B&W monitor and a 9-pin printer. It is usable for word processing, spreadsheets, data base management and most applications that do not require a hard disk. Cost of the complete system is about $860.

"Windows" system

Recently, a graphical user interface, Windows by Microsoft, has exploded in popularity. It is highly demanding of the disk, processor, memory and graphics display. This leads many to ask what is a good setup for running Windows. Start with a fast 286 and 4 MB of memory, add a floppy and 40 MB hard disk, 640 x 480 VGA display and controller, printer port, serial port and mouse and Windows software. With printer, the cost is about $1,710. At 40 Watts, it is a modest load.

Wrapping up

Remember the 174,000 Watt ENIAC? We now have computers that need 7,000 times less power while running thousands of times faster, as well.

ACCESS

John C. Osborne, AirCastle Enterprises, 15926 Northville Road, Plymouth, Michigan 48170, • (313) 348-7135.

For Spacious Skies... An Alternative

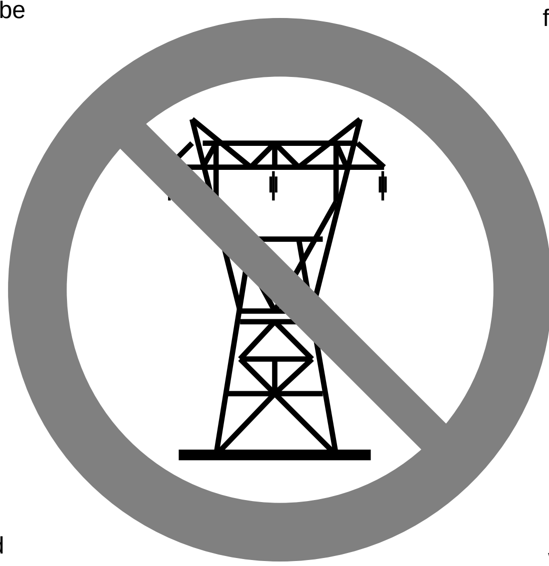
Lyn Mosurinjohn

The issue of how to generate power has landed squarely in the lap of Central Wisconsin; heart of America's Dairyland. The controversy was sparked by a notice to property owners from New London to Stevens Point of one of the largest bulk transmission line projects ever to be proposed in the state. It could cut 80-100 foot swatches through some of Wisconsin's most beautiful terrain: wooded hillsides, diverse wetlands, and picturesque farmland. Industry representatives assert that the need for high voltage upgrades has already been established. Increased loads, coupled with dilapidated lines in Central Wisconsin, threaten reliability to local service. While landowners, many of whom are fresh from hosting the Midwest Renewable Energy Fair in August of this year, are asking if this isn't the time to seriously explore Energy Conservation and Renewable Technologies. A citizens group for Promoting Options for Wise Energy Regulation- POWER, has taken the position that how to meet forecast needs has not been responsibly examined.

Cobwebs

Also at play is the issue of west to east transfer capabilities, to which Central Wisconsin is key. Growing demand on the heavily populated eastern half of the state has raised the dilemma of whether and how to transfer available power from the western portions. The Wisconsin-Upper Michigan systems are heavily dependent upon coal fired and nuclear power plants that are coming under increasing scrutiny for emissions associated with acid rain and global warming, and for safety and waste disposal considerations. Both may be facing tougher operating restrictions as clean air compliance and global warming trends come under legislative investigation. Power transfers from Hydro-Quebec have been in consideration for some time now as a possible solution to diversification. But inherent in that solution is a whole new Pandora's box of risks to the environment.

Acid rain is already reeking havoc on Wisconsin's lakes. The citizens of Shawano and Waupaca Counties have already been brushed by the threat of a nuclear waste disposal site in their backyards. And the state's "beautiful, for spacious skies" are becoming cobwebbed with overhead transmission and distribution wires. POWER is saying, **"ENOUGH!"**



Stewardship

Stewardship of the land is not a new concept to the people affected by this project. Many are third and fourth generation farmers. "Newcomers" are attracted to the sheer beauty, rich wildlife habitat, folk culture, and strong community values. Central Wisconsin is a rewarding place to put down roots, build a home, and raise a family. Ironically, many of the people building in this part of the state power their homes with wind or solar technologies. Dissecting their properties with a mesh of high voltage wires seems a strange reward for efforts toward ecological consciousness.

Pulling Together

Affected property owner, Tom Pease, called friends and neighbors together at his home within days of receiving his notice, two days after the close of the Energy Fair. Forty-eight people attended that impromptu, word-of-mouth gathering. The objective was clear.

"The utilities have the right, by law, to propose all these alternate routes," recalls Pease. "Call it what you may, but it's sure to their advantage... divide and conquer." The people of this community are quite diverse. But first and foremost, we are a community. I for one, or the group I belong to (POWER), will not say, "Don't put it here, put it in my neighbor's yard." We say, "Don't do it. You haven't exhausted your conservation options. You have not looked seriously at renewables."

Beyond refusing to make route endorsements which cancel out each other's concerns, POWER asserts that the need for the voltage upgrades must be clearly proven. That if health effects (with particular attention to electromagnetic field exposure) and environmental damage are potential by-products, that conservation and renewables must be explored first.

Encouragement

With the encouragement and steerage of members of the Midwest Renewable Energy Association, Environmental Decade, Wisconsin's Citizens Utility Board, and others, POWER has incorporated and hired legal representation. The Wisconsin regulatory process requires a public hearing as part of the utility project review. Citizens may participate as full parties in that contested case hearing. POWER's attorneys have already filed the groups letter-of-intent to do so.

Key Issues

The membership has identified several key issues to research and make recommendations on for the presentation at the upcoming hearing. Among them; environmental impacts, health effects, need

assessment, and conservation/renewables. The work ahead is to develop policies regarding each of those concerns and to gather data and expert testimony to support them.

Despite insinuations that one 138 KV transmission line and its supporting substations is "peanuts", POWER sees the task ahead as enormous. One hundred plus miles of line will impact untold acres of highly diversified habitat, much of it heretofore undisturbed. In view of changes to global climate and threats to biological diversity, POWER believes we have spent all the trees we can afford to spend, have compromised all the wetlands and watersheds, have sacrificed all the resources we dare to. Not the least of which is our own genetic pool. The issue of the potential health effects of electromagnetic field exposure is explosive. It is not enough, say POWER's members to say that transmission is only a small part of the EMF problem. We have to start setting limits on the risks we are prepared to take to our health and that of the environment. For POWER, this is the line.

"Maybe this is the time", notes POWER's secretary, Lyn Mosurinjohn, "when least-cost is no longer equated in mere dollar value. There is more to factor into the cost of our power addiction than monetary expenses. We are paying the price with our health and our environmental quality. We are paying dearly. Maybe the time is ripe to set new standards. To move toward conservation. To clear the cobwebs from the sky."

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Promoting Options for Wise Energy Regulation (POWER)

Lyn Mosurinjohn, Secretary

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Things that Work!

Statpower's PROwatt 600 Inverter

Richard Perez

This midget inverter is amazing. It is the most silent and smallest 600 watt inverter we have ever used. It faultlessly inverts battery stored 12 VDC power into modified sine-wave 120 vac. Technically, the PROwatt is revolutionary because it doesn't use a heavy, bulky, and expensive power transformer. Instead this inverter uses a high frequency DC to DC switching type converter. This makes the PROwatt 600 physically tiny in relation to its power output.

Shipping container and Documentation

The Statpower PROwatt 600 arrived via UPS in a rugged shipping container protected with styrofoam inserts. The documentation provided with the inverter was some of the best inverter docs I have ever read. The docs are thorough, non-technical, and well illustrated. Many details on applying the PROwatt 600 in a system, both stationary and RV, are included. Good job on your documentation, Statpower.

The PROwatt 600 Specifications

Statpower rates the inverter at an output 120 vac wattage of 600 watts. Its continuous output rating is 500 watts at room temperature. Surge output wattage rating is 1,500 watts. The PROwatt 600's output waveform is rated at 115 vac RMS, ± 5% and at 60 Hz, ± 0.01%. The inverter is protected against all types of damage- input over voltage, input under voltage, output over load, and over temperature. The inverter has phase-corrected output which means that it compatible with inductive loads. An inductive load contains a transformer (like just about all 120 vac stereos, VCRs, TV, computers, etc.) or an electric motor, or fluorescent lighting.

Physically the inverter is tiny. It measures three inches tall by nine inches wide by ten inches long. It weighs five pounds. This is about one quarter the size and weight of any other 600 watt inverter. Statpower has used what is called "switching" power supply technology to produce a very small and powerful inverter.

How is a "switcher" different?

In most inverters, switching is accomplished at 60 Hz. (cycles per second) into the low voltage side (primary) of a transformer. The transformer then steps up the switched 12 VDC input to 117 vac rms output on the transformer's secondary. Statpower's approach is different. The PROwatt 600 uses a 12 VDC to 145 VDC switching converter that operates at many thousands of cycles per second instead of 60 Hz. This increase in the frequency of the voltage's up conversion radically reduces the size of transformer used in the switcher. Switching power supply technology has been around for a while in computer equipment. It has been proven reliable, rugged, and tiny in relation to transformer operated at 60 Hz. After the PROwatt 600 has produced 145 VDC (via the switcher), then the inverter uses FETs to chop the high voltage DC into modified sine-wave power at 60 cycles per second. Net result is a quiet and powerful inverter in a tiny package.

Test System

I installed the PROwatt 600 on our test system at Agate Flat, Oregon. This system is based around a 100 Ampere-hour nicad battery composed of ten-series connected Alcad UHP100 cells. The power source is two PV modules (an ARCO M75 and a Solar MSX-60), with an output around 5.5 Amps. The system uses a CC20 Heliotrope PV regulator. I set the CC20 to regulate at 14.75 VDC to accommodate the PROwatt 600's high voltage shutoff limit of 14.8 (measured by testing the PROwatt 600).

The PROwatt 600 was connected to the high rate nickel-cadmium battery with two cables. Each #4 gauge copper cable was four feet long and equipped with soldered monster connectors on the battery ends. See HP#7 for details on how to make these solder cable to battery connectors yourself. The inverter accepts up to #4 gauge copper cable directly into color coded female connectors on the inverter's back. The PROwatt 600's 12 vac was taken from one of the two outlets on the inverter's front and run into a switched plug strip.

The PROwatt 600's performance was measured by a Fluke 87 true rms reading Digital Multimeter and a Thandar oscilloscope.

PROwatt 600 User Performance Data

This inverter performs faultlessly. It is absolutely the least noisy inverter of any size that I have ever used. The PROwatt 600s is totally silent to my ears. It runs every inductive load (within its power range) we have plugged into it. I pushed the inverter to all of its protection parameters and it in fact protected itself from damage due to overvoltage, undervoltage, and overload.

We powered a variety of appliances, but went heavy on the inductive loads. The PROwatt 600 powered OSRAM Dulux fluorescent lighting, a Singer sewing machine, a video camcorder setup, a 350 watt solder gun (with transformer inside), a 350 watt electric drill, and a coffee grinder. I also tested the PROwatt 600 on delicate electronic stuff like a satellite TV system, Macintosh computers and printers. All performed well. In some cases, problem loads (like Karen's 10 watt 120 vac electric sewing scissors), ran better on the PROwatt 600 than on other small inverters we've used.

There are several user features we really appreciated in the PROwatt 600. One is the color coded LED bargraph meters built into the inverter's front panel. Here two bargraphs measure battery voltage (10 to 15 VDC in 0.5 VDC steps) and inverter DC input amperage (0 to 100 Amperes in 5 Ampere steps). The PROwatt 600 also has audio beepers that warn the user of over and under battery voltage.

PROwatt 600 Techie Performance Data

No load power consumption on the PROwatt 600 is about 280 mA. at 13.6 VDC (that's 3.8 Watts). This particular PROwatt 600 shuts down at 14.8 VDC. on high battery voltage and 10.5 VDC on low

battery voltage. The efficiencies I measured were within the >90% range specified by Statpower. Peak voltage output remained at >140 vac pp until gross overloading (at about 800 Watts). RMS voltage remained at between 105 and 115 vac until overload.

PROwatt 600 Applications

This is the perfect inverter for small systems who have started out on 12 VDC use only. It is as at home in mountain cabins as RVs. The PROwatt 600 is also a fine second inverter for larger systems. The second inverter supplies delicate electronics like audio/video gear or computers while the system's larger inverter supplies the big loads like washing machines, pumps, and vacuum cleaners. Both inverters may be fed from the same battery and power source(s).

And a Wart…

My only objection to this inverter is that it interferes with radio equipment. We discovered RFI as high as channel 5 on a nearby portable TV. I called Frank Peabody at Statpower. Frank told me that Statpower is aware of the RFI problem in the PROwatt 600 and will correct it.

Conclusions

The tiny PROwatt 600 is a very effective, silent inverter. The inverter does all its maker says it will, and it our testing even more. It is worth its US list price of $499.00 and a Canadian price of $640.00.

Access

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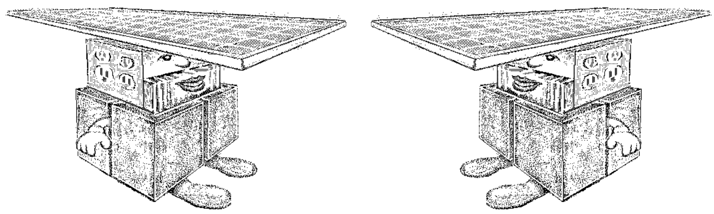
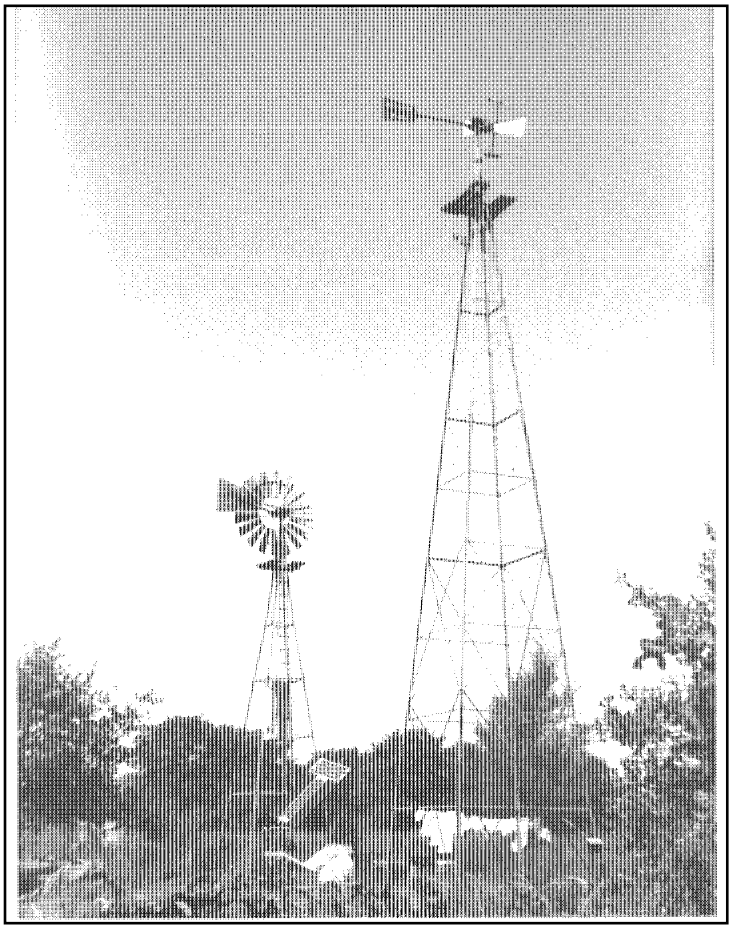
Manufacturer: Statpower Technologies Corp., 7012 Lougheed Hwy., Burnaby, B.C. V5A 1W2. Phone: 604-420-1585 • FAX: 604-420-1591.

System Shorties



System Shorties are brief notes from readers about their home power systems. To join the party, send material similar in spirit to what you see here. We will edit for clarity and conciseness.



Sun & Wind in Oklahoma

We really look forward to each issue of Home Power. I have constructed a number of the electronic circuits that have appeared. We also have made a number of purchases from your advertisers. HP really keeps us in touch with what is happening in renewable energy. We are blessed with abundant sunshine and wind here in central Oklahoma, but people here aren't aware that it's possible to power a home with renewable energy. We give "tours" of our place to anyone who is interested and do what we can to spread the word. We've never actually met anyone else using a wind and PV. So at times we feel kind of alone and HP fills the void.

We're only about 900' from a power line but never considered anything but wind and solar power, right from the start. At this point we have about all we need; a 60 year old Aermotor water pump which also provides mechanical energy for a Wincharger with a 12 volt, 40 amp generator and four PV panels of differing age and manufacturer. PV is our main source of electricity with the Wincharger only used during cloudy periods or if were using the tools in the shop or garden. We've never had a back-up generator thanks to the fact that we have two sources of renewable energy.

We have one set of (2) Trojan golf cart batteries that have been in use for 11 years. Eighteen months ago we purchased a Sun Frost refrigerator and added two Trojan L-16Ws.

We also garden with renewable energy. I've built a rear-tined rotary tiller that runs on 12 VDC and have also converted a compost shredder to 12 VDC. Most of our firewood is cut by hand with some help from a Mini Brute 12 volt chainsaw.

The most recent project is a battery operated sickle bar mower. It's an old David Bradley (Sears) walking tractor converted to 12 VDC with two golf cart batteries for power and a Jari sickle bar mounted on the front. I have hopes in the future to do a variety of homestead tasks with the electric walking tractor.

I hope someday to contribute an article. But it seems any spare time is filled working on some project inspired by Home Power! Keep up the good work. May it always be a joy and don't forget to take a break whenever you need it.

Bruce Johnson & Barbara Hagen, Spencer, OK

DWH & a side of Composting

I was at first turned off by the color cover but greatly understand the importance of making a decisive move toward a mass market at this critical time. I appreciate the effort taken to find the soy based ink and see the tough decision behind the bulk paper question. A Willits company is now working on composting machines to digest toxic wastes, such as printing waste, using horse manure. Limiting color to the cover is my vote.

A brief description of our home; eight panels charge 16 Trojan L16s at 24 volts. We use DC for lights and refrigeration. A Trace 2024 inverter provided ac for the power saws to build our home and continues to provide the modern conveniences.

Hot water comes from a 4 x 8 Heliodyne solar panel with a Holley Hydro stove insert. Both operate on a thermal siphon to a 55 gallon stainless steel industrial surplus drum for a tank. The panel gives us 55 gallons of scalding hot water. This winter we will test the Holley. We are semi-coastal so freezing weather is limited to a couple of months when we drain the Heliodyne. An Aqua Star with solar option provided hot water until we were ready to go solar. It is now used only when it rains and we don't have a fire or on warm winter days between freezes.

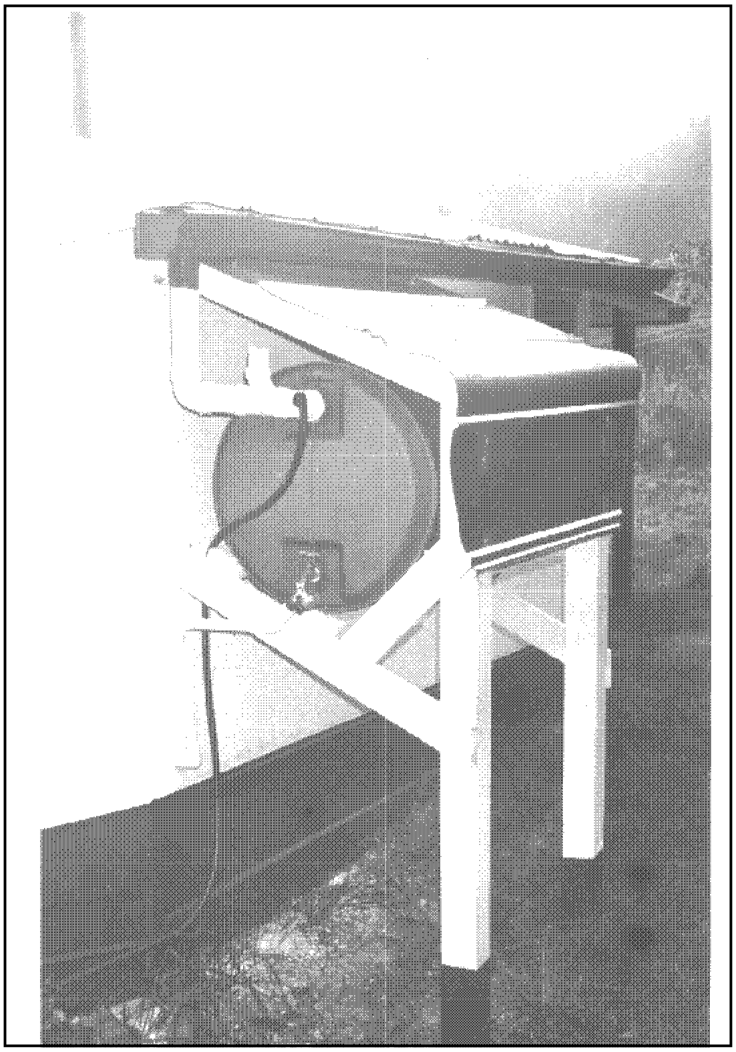
A Boli NE composting toilet saves on water and a septic system but also provides high quality compost for our veggie garden. The only hitch is that the NE is not large enough to allow long waits between emptying and so we compost further with a simple setup. A 55 gallon plastic drum with the bottom cut out and holes drilled all around for air makes a perfect low volume composter. We add all kitchen scraps either directly to the toilet or to the drum. Sawdust is also added at both stages. Weeds and yard scrapes go in as well. Every two to six months, when it's full, we tip it over and shovel out the bottom third to half. Wonderful stuff, without any offensive odor. Back into the garden it goes for recycling of the most basic kind.

Walt Stillman, POB 536, Point Arena, CA 95468

P.S. I agree with Richard Perez that we tend to focus on equipment rather than people. How about some in-depth interviews, not just with the movers and shakers in the business, most of whom are probably men, but also women of vision whose courage and creativity in passively harvesting natures energy helps move us away from the distraction of our toys to the bounty of the land & sun.

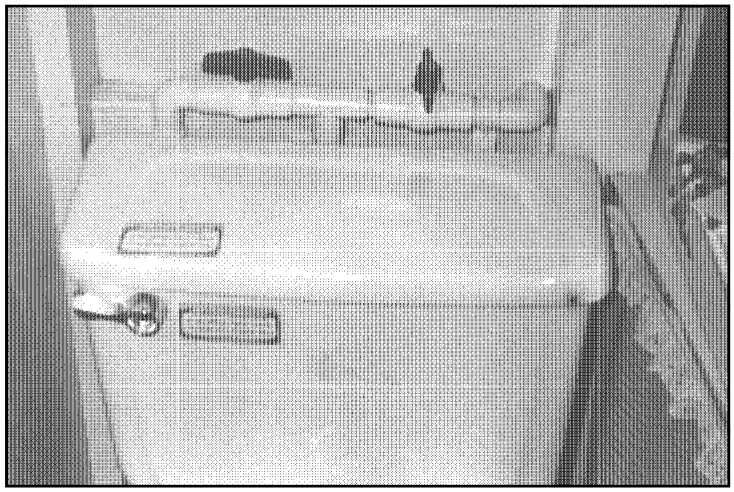
Flushing with Rainwater

Just when we were building our bathroom I read, in an old issue of Home Power, of a family who built their homestead and said, "The only thing we'd have done differently was collect rainwater for flushing the toilet." I thought, what a great idea! Rainwater is free and doesn't need to be sterile to flush. It can be kept well with a few



drops of bleach added monthly.

The gutter (with leaf trap and screen in the drain hole) goes into the 55 gallon plastic cider barrel with PVC pipe. Epoxy connects and fills the gaps. There is an over flow hose drain and a pop off relief cap. A faucet is screwed into the bottom of the barrel. A "Y" with a cap is used if I ever need to drain the barrel and the other part goes to the toilet via PVC pipe. Inside there are two ball valves, one from the rain barrel and one from the main water supply. When we run out of rain water, we close that valve and open the other one. We just don't open them both or the rain barrel will get filled up by the



main water supply. Its been working well for several months and has saved plenty of water.

The height of the lower part of the rain barrel is just a few inches above the top of the toilet and, of course, is gravity fed. This works fine for most toilets- ours is a 1.5 gallon flush model- but wouldn't be enough pressure for certain pressure-flush models like the Watersaver®. I know; we tried it first.

The barrel is supported by 2, 4"x4"s and the bathroom wall and 2"x4"s that are all pressure treated. It's covered with a tin roof to keep the water cool (to reduce bacteria buildup if bleach gets low).

It's a simple system, works well and save potable water. Thanks for listening. Keep up your fine, informative writing.

Larry Behnke, High Springs, FL

An Old Friend

Love your magazine! You even turned up a source of an old friend in info for rewinding generators for slow-speed (pg. 25, HP19). I still have a Le Joy manual, but haven't seen an "Auto Power" for neigh 40 years! I used to rewind four cylinder Dodge starter generators, just about for fun, in the '40s, using their guidance & learned basics.

We had the first wind power on the coast, at our remote ranch 55 miles south of Monterey, CA. Had 56 glass cells @ 2 volts each; came by boat and landed on the beach in 1930. A geared-up 3 to 1 generator had a 12 ft. prop. It worked fine for a total of 19 years, when the batteries finally killed us. We still don't have grid power. I use two panels & 2 T105s with a standby generator for appliances and tools.

Couldn't pass up reliving some history, too. Don Harlan, Big Sur, CA

COGEN

We are now producing all of our electrical and heat needs from firewood fuel, mostly Palo Verde, creosote, and mesquite. These, along with horse manure and paper trash, are placed into a "gas producer" where very high temperature oxidation, reduction, and pyrolysis convert these into a combustible gas similar to natural gas but of lower heat content. This fuels our gas engine generator which is used to charge batteries and the waste heat is captured and stored as hot water for home heating. The system consists of:

1. The gas producer was very difficult to get working. I spent many days in the library reading alternate energy textbooks and articles on the subject, but failed to find any working plans. These units were very common in rural areas from 1890 to 1920 or so, and were

used to power small stationary farm engines. It was the producer gas engine that caused the phasing out of small Sterling engines, much used from 1880-1900, due to much lower price and greater efficiency. Producer gas engines use about half as much fuel as their Stirling counterparts in small sizes of a few horsepower. Steam engines of this size would also be inefficient and very expensive. I had to build and test several producers before I had one that worked well. The current model was built in two days at a cost of under $50. It has operated well with all fuels, including coal, charcoal, various woods, horse manure, trash, and peat moss. Mixes of these fuels are usually used.

2. A Coleman Powermate 2800 gas engine generator that has been converted for this fuel with a gas mixing valve and by advancing the timing about 4°. This generator will put out 1400 watts maximum on this fuel. With a 1200 watt load it consumes ten pounds of dry wood per hour. The oil runs very clean and there are no signs of problems. Engine life should be enhanced with this fuel, but it's too early to tell.

3. A dual loop heat exchanger that captures both hot engine generator cooling air and exhaust gases and stores about 30,000 BTUs of heat per hour in 180° water which provides much more heat than we ever need in Arizona.

4. A Heliotrope HC-75 Battery Charger, which works super.

5. A battery bank consisting of four Trojan L-16Ws, wired in series/parallel providing 12 VDC at 700 amp hour capacity. At our use level, the generator is used for about four hours per day, usually in the evening.

6. A Powerstar inverter that operates electronics.

7. A low voltage wiring system to operate lights &DC cooler motor.

This system is a viable supplement or alternative that should make you cringe less when needing to start the generator in terms of both dollars and the environment. Our heat exchangers greatly quiet the noise, and a special mounting arrangement makes it so that we hardly hear it running. A gas engine is an excellent furnace! Anyone that burns firewood for heat will find that a system like this will provide more heat for a given amount of fuel while providing useful electric virtually for free.

Gene A. Townsend, 36515 Twin Hawks Lane, Marana, AZ 85653

HAPPENINGS

Southwest Regional Energy Fair 1991

The New Mexico Solar Energy Industry Association (NMSEIA) will be hosting its annual SW Regional Energy Fair (SREF) on May 17 to 19 1991. This event will emphasize education, encompassing all forms of energy indigenous to the southwest region. Workshops, seminars, open forums, and historical and commercial exhibits will focus on energy conservation, building materials and equipment common to the southwest.

The Fair will be held at Zocalo in Bernallillo, New Mexico (20 miles north of Albuquerque). This site on the Rio Grande River has many historic adobe buildings, including an 1860's convent which is now a fine restaurant.

To date, the Fair has solicited the support of many regional and national manufacturers wholesalers, including Zomeworks, SunEarth, Independent Energy, Solarex, Flowlight, SEMCO, Alternative Energy Tech., SolarJack, Bobier, DHW., Brother Sun, Grundfos, Solar Industries, Trace, Hoxan and more.

Presently 35% of the booth spaces have been reserved. They are available in units of 10'x10' for $150. & 10'x20' for $300. Priority is being given to exhibitors from the Southwest (Colorado, new Mexico, Arizona, Utah, Texas, & Oklahoma). Corporate sponsorships from $150.00 to $500.00. Personal sponsorships are $40.00 for families & $25.00 for individuals. All levels of sponsorship come with fair passes, hats or T-shirts, & fair program. The fair program will contain summaries of the presentations, as well as a regional Business and Service Directory. Please contact Smitty at SEMCO (505)247-4522 for more information.

"The Southwest Region is where many solar technologies first developed. This fair will demonstrate not only the latest, but also the time-tested technologies for the independent power user." Windy Dankoff, Home Power author & owner of Flowlight Solar Power.

"In New Mexico we have been successful at staying comfortable using the heat of the sun and the cool of the night. Our tools have been old fashioned adobe bricks, timbers, and glass. At our energy fair we will dwell on these new materials...plastic foam insulation, plastic glazings, new optical coatings, electric pumps and fans as well as our most recent of all, electricity direct from the sun.

You will also hear opinions about energy policy from some in the field who have invested more of their own sweat than other taxpayers' money." Steve Bear, Zomeworks, SREF Director of Education.

"Active solar, passive solar, education and energy conservation. Everything people need to make the right decision in the '90's". Bill Yander, Brother Sun

"Thanks to the hard working people and their successes at last year's SEER and the Midwest Renewable Energy Fair, I've seen manufacturers of renewable energy equipment becoming increasingly supportive of our efforts in this regard." Jeff "Smitty" Schmitt, SEMCO, SREF Director of Funding.

"We are proud of what the private sector is doing and think they are going to hit a home run with this year's Fair." Charles P. Wood, State of NM Energy, Minerals and Natural Resources Department.

"The Southwest Regional Energy Fair will be an opportunity for the new age consumers to meet with the solar survivors. A day in the sun to learn what the past 10 years have blended from technology and experience without the dazzle and high pressure sales that plagued the industry in the past." Chris Fairchild, Diversified Heating Wholesalers, Inc., President NMSEIA

Hands-On Workshops in Maine

The Maine Solar Energy Association has started a series of hand-on solar workshops all around the state of Maine. The purpose of these practical, one day events is to de-mystify solar energy by showing the participants that it is practical today to use the sun to heat your home, make your hot water, furnish your electricity, and even cook your food and grow your vegetables out of season. In the past year we have had a very successful passive solar architecture workshop in Bangor, a solar greenhouse & sunspace workshop in Falmouth, and two photovoltaics workshops. The participants of the photovoltaic workshops actually constructed solar cell modules that they could take home for the cost of the parts. Some people made small solar battery chargers. Several participants assembled large 35 watt power modules.

In the coming year the expanded schedule of workshops will include; solar air heating, solar water heating, solar cookers and ovens, solar electric home, passive architecture, greenhouses and sun spaces, and the immensely popular photovoltaics workshop. The fee for each of these workshops is $25.00, which includes lunch.

For information on sites and dates contact the Maine Solar Energy Association, RFD Box 751, Addison, ME 04606, 207•497-2204

Florida Solar Energy Center

Workshop Schedule for 1991 (subject to change)

The Photovoltaic System Design Workshop will be held at the Florida Solar Energy Center on, March 5-7, June 4-6, & Oct. 22-24, 1991. This workshop will cover solar electric technology and the design of stand-alone and utility interactive PV systems aimed at engineers, government agencies, the solar industry and interested individuals. Cost $150, in-state, $300 out of state.

Energy Efficient FL Home Building: the newest ideas on designing & building an energy efficient home for home builders, inspectors & those thinking about building. 5/1 (Naples), 5/2 (St Petersburg), 5/21 (Pensacola), 5/22 (Panama City), 5/23 (Tallahasse) and 9/19 (Orlando) 1991. Cost is $45.

For more information contact JoAnn Stirling, 300 State Rd. 401, Cape Canaveral, FL 32920-4099 • 407-783-0300

NE Sustainable Energy Assoc.

March 1-3, 1991 - 8th annual QUALITY BUILDING CONFERENCE, sponsored by the Quality Building Council of the NESEA, Springfield, MA. Contact: NESEA • 413-774-6051

May 21-25, 1991 - 3rd annual AMERICAN TOUR de SOL, The solar & electric vehicle championship, sponsored by NESEA, Albany, NY to Boston, MA. Contact: NESEA • 413-774-6051

May 24-26. 1991 - ENERGY AND ENVIRONMENTAL FAIR, Plymouth, MA. Contact Earth Rising Productions • 617-489-4890.

SunAmp Seminar

SunAmp Power Co. will hold a 2 day PV seminar Jan.18 & 19, 1991. The seminar is designed for everyone from professionals to do-it-your-selfers. Topics will include introduction to PV hardware, demonstrations of systems, instrumentation, information access, system design and marketing. Cost of the seminar is $145.00 ($100. for each additional person in the same party) and includes two lunches, refreshments, syllabus & classroom materials. For more information contact Steve at SunAmp Power Co., POB 6346, Scottsdale, AZ 85261-6346 • 602-951-0699 or TOLL FREE 1-800-MR SOLAR.

Minnesota Energy Council

The MN Energy Council will hold a number of conferences on new technology in energy and environmental management for housing, small buildings, small business and municipal buildings, aimed at professionals and business people. For more information contact: Roger Peterson, Minnesota Energy Council, Box 8222, St. Paul, MN 55108 • 612-378-2973

IS PV GOING TO GROW UP?

John Wiles

From time to time we must go back and examine where we are and how we got there. This is one of those times. The National Electric Code is just that-- a national code for all electrical power systems. It has evolved over the last 100 years or so and is in effect throughout the entire United States. In some areas even more stringent codes are in use. These codes are safety oriented and do not specify how the requirement is to be achieved or what equipment is to be used. The National Fire Protection Association who publishes the NEC is not in the equipment development business so the NEC is not the proper place to discuss implementation of the requirements.

These Code Corner columns are being written to achieve one objective: The Widespread Use of Cost Effective, Safe, Reliable, and Durable Photovoltaic Power Systems.

The material presented here is a distillation of over 18 months of research carried out under contract to the U. S. Department of Energy. This material has been reviewed by over 300 persons in the PV industry and revisions and comments from nearly 60 manufacturers, distributors, dealers and installers have been incorporated. Feedback from workshops to the general public, dealers, electric utilities, and electric inspectors has also been used in determining the contents of this column. The techniques discussed to meet the NEC and those that don't are based on PV systems being installed today and on tests and evaluations of more than 200 PV systems and nearly a quarter million PV modules in systems over the last decade.

History

Although most commercial power in the U.S. is alternating current (ac), the NEC was initially developed in the days when Edison was still around and direct current (dc) power systems were far more common than ac systems. Even now, some industries such as mining and ore reduction still use dc power. High current battery systems abound as uninterruptible power systems (UPS) are used to keep computers on line when the grid power goes down. The NEC covers all of the systems in use for alternate energy including back up generators, batteries, hydro, wind, PV, etc. It also deals with low voltage, high power systems. The people who write and constantly revise the NEC are "hands on" professionals in various segments of the electric power industry who don't rely on "feelings" to get the job done. Most have been designing, building, and installing electric power equipment and systems for far longer than the terrestrial PV power industry has been in existence. If you own a copy of the NEC, you will know that there is a straight forward procedure for submitting proposed changes -- changes which must be based on cold, hard facts and test data -- not guesses and suppositions.

Current Events

In August in New Haven, CT an electrician/electrical contractor was sentenced to five years imprisonment and an additional five years probation after being found guilty of second-degree manslaughter due to an electrical fire that claimed the life of a 12 year old boy. No, it wasn't a PV system, but the investigation revealed that 19 sections of the local/National Electrical Code had been violated.

Safe or Sorry?

Who will pay the piper when a PV system which is not factually and demonstrably safe, burns up a house or kills someone? Who will pay when little Timmy tries to help Daddy and drops a wrench across the inverter terminals on a system you "felt" was safe without fuses between the battery and the inverter? It is going to take just one major PV accident for the insurance industry or the electrical inspectors to put us all out of business.

Recent Problems, Understanding, and Solutions

Much attention has been recently directed toward the problem of excessive voltage drop between the battery and inverter when the guidelines in the NEC are followed with respect to overcurrent protection and disconnects. The specific facts and connection arrangements used at SEER 90 are not available, but consider the following: All provisions of the NEC in this particular case can be served by a single circuit breaker between the battery and the inverter. The circuit breaker can provide the disconnect for the inverter, the overcurrent protection for the wiring to the inverter, 30 times rating inrush protection, and 10 times rating surge protection. The circuit breaker can interrupt 25,000 amps on systems with less than 65 volts. A circuit breaker of this type has a terminal to terminal resistance of less than 0.001 (one milliohm). Of course, the circuit breaker must be connected to the circuit.

Utility companies routinely make crimped connections to terminals and breakers like this with much less than one milliohm resistance-- and they don't use solder! At 1000 amps, even a 0.001 ohm connection would loose 1000 Watts of power and not even the utility companies can afford that. The added (for NEC requirements) resistance is less than 0.003 ohms (connections plus internal resistance of the circuit breaker) which yields 0.3 volts drop at 100 amps and 0.6 volts drop at 200 amps. During 1000 amp surges, the added drop is 3 volts, but the inverter manufacturer should take this into account in their designs. The circuit breaker mentioned in sizes up to 110 amps costs less than $50 in quantity buys.

There will always be voltage drops due to cable length and size, less than ideal connections, and disconnect and overcurrent devices. As PV systems spread, the inverter manufacturers are going to have to acknowledge these real-world conditions and requirements. They will add remote battery sensing leads for the low voltage cut-off function and a few extra turns in the transformer to deal with the sagging output voltage under surge conditions. They may even be more creative in their solutions and some manufacturers have already addressed the surge issue. Remember they are part of our industry and part of the problem as well as potentially part of the solution.

The PV industry is very small when compared with even the UPS industry. The UPS people deal routinely and effectively with 100's of amps of current and meet UL and NEC requirements so I suspect

we in PV will not be able to generate much enthusiasm for low cost, ultra low loss equipment. It is already available -- if you have $$$$, but there are much easier and cheaper solutions within our own PV/inverter industry.

Incidentally, those of us who remain at 12 volts with inverters which draw more than 100 amps at full output will find that disconnect and overcurrent equipment prices increase by a factor of three or more as we go past 100 amps. After all, we are demanding low, low contact resistance, aren't we?

The Choice Is Yours

Code Corner is written to present solutions to the PV user that meet the legally mandated, existing requirements of the National Electric Code. I make every attempt to find available, low cost, reliable solutions to the perceived problems we face, since I too am paying the bill for my alternate energy system. You don't have to implement any safety considerations in your system if you choose not to, but you must also be willing to stand responsible for the consequences of your actions.

Access

John Wiles, Southwest Region Experiment Station, PO Box 30001/Dept 3 SOL, Las Cruces, NM 88003 • 505-646-1846.

The Wizard Speaks…

Solar Power

It's time to stop beating around the bush. Global warming, acid rain, and pollution are and will continue to be major problems. Solutions must begin to be implemented to address these dire problems of the biosphere. We, the human race, must take action soon or we may not be able to take any action at all. In fact, we may not even be here to take any action. Them's the facts folks. It's up to us to act on them.

So you ask "What can be done?" It's really simple. Begin immediately to replace all fossil and nuclear power plants with photovoltaics, using hydrogen, hydrides, or hydrogen fuel cells as storage media. Replace gasoline and other fossil fuels with these same hydrogen agents. The only argument against these measures is cost. Costs can be reduced greatly by using energy efficient appliances, especially lighting, refrigeration, and electronics. Conservation can also reduce costs. Besides, there is no choice. What's the earth to you? Do it now!

(The present crisis in the Middle East brings this all home now. Oil will not last forever. It is better to replace it now, than to wait until it is all gone. WIZ)

Letters to Home Power

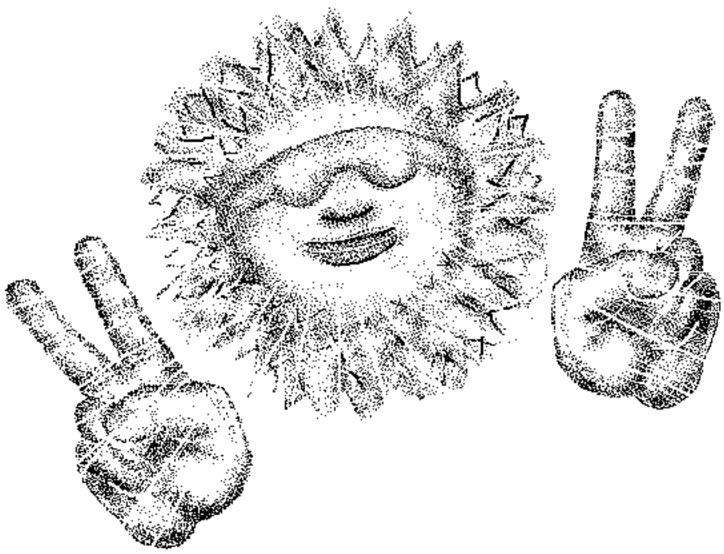
We Print 'em Unedited.
Selected & Entered by
Kathleen Jarschke-Schultze

CRUDE DEFENSE

I'm going to Saudi Arabia as part of "Desert Shield". I predict that sooner than most Americans would wish, the equipment and techniques described in your magazine will become more essential. Larger scale previous use in the last 17 years could well have prevented this tres expensive military buildup. I think you are all the real patriots.

Name withheld by Letter's Author

It is our sincere and fervent hope that all goes well for you there, that you return safely, and that you don't have to kill anyone. KJS



SOLARMAN SPEAKS

Stuart Ward was correct in issue #19 when he suggested one PV panel can be plenty. I run my entire home on three. My PV rack (built from Richard Perez's "How to Mount and Wire PV Modules" in HOME POWER #2) is set up for four modules and I keep eyeing that empty spot, but I just don't need the power.

I would add to Stuart's point that solar is such a beautiful building block concept. Start with one module and, if it's not quite enough, add another. As you purchase more electric devices just add PV modules when you need them.

Phil Wilcox, Lower Lake, CA.

GRASSROOTS IN POLAND

A town in Poland and a small Connecticut City. The environment. Schoolchildren. Grassroots Action.

These are the ingredients of a story which will unfold this week as a small party of Winsted, Connecticut residents travels to Milanowek, Poland in a sister-city program with an environmental twist. Comprised of a state representative, a businessman, a conservation expert from the local utility and two seventh graders, the group is involved in establishing an on-going dialogue about conservation with their Polish counterparts. Going beyond talk, they also plan to introduce energy and water saving devices, and to teach the art of composting.

Last fall, when Poland's new environment minister Bronislaw Kaminski took office, he said, "From the mountain of things we have to do, I want to cut off the peak." Hank Ryan, on the other hand, wants to chip away at the base. As owner of Firstconserve, a Winsted based distributor of conservation products, Ryan knows the savings in energy, pollution-- and money-- that simple individual actions such as switching to energy efficient lighting or a water saving toilet can bring.

Ryan also knows how to effect the switch. In Winsted, he's organized a program to give free 1.6 gallon toilets to residents around Highland Lake in an effort to reduce sewage spills. (On Sunday afternoons one is likely to find him delivering one of these toilets in a canoe, complete with flowers in the bowl.) And he's spearheaded a project to retrofit municipal buildings in Winsted with Compact Fluorescent lightbulbs, saving taxpayers thousands of dollars in utility bills. Now Ryan's out to do the same in Poland, where heavily subsidized heat and electricity stunted the development of of a conservation ethic.

While world powers talk of millions in ecological aid, this program is pure grassroots, conducted businessman-to-businessman, person-to-person, even child-to-child-- the two town's schools are linked by computers and FAX machines donated by Ryan, so students can trade perspectives on the environment across the miles. "The most important ingredient in a relationship is the children." Ryan says, concerned that today's young people grow up seeing the hope and joy in environmentalism, instead of having it fill them with fear and despair.

The current delegation leaves on August 8th and returns on the 16th. I'll try to reach you beforehand to see if you might be interested in an interview (with Hank Ryan, Rep. Joel Gordes, Northeast Utility's Mike Viccaro and/or the two seventh graders) upon their return, or perhaps a by-lined article. Thanks for your consideration.

Freda Eisenberg, Winsted, CT

The crew just loved the picture of Ryan in the canoe delivering the toilet. The flowers are a great touch. KJS

MOBILE HOME POWER

I just recently purchased an Arco solar photovoltaic panel for my rural Hinckley, MN farm. I have constructed a metal frame box that holds the solar frame that will be put on the roof of my mobile home. I have 12 gauge copper stranded wire which will be attached to a M8 Controller and then to two deep cycle batteries 12 VDC. I have four incandescents and one fluorescent lamps, one car radio and one 12 VDC toilet that will use the 12 VDC. I plan on a fused junction box and each light will be fused. What else must I know and do?

Nicholas Schneder, St Paul, MN

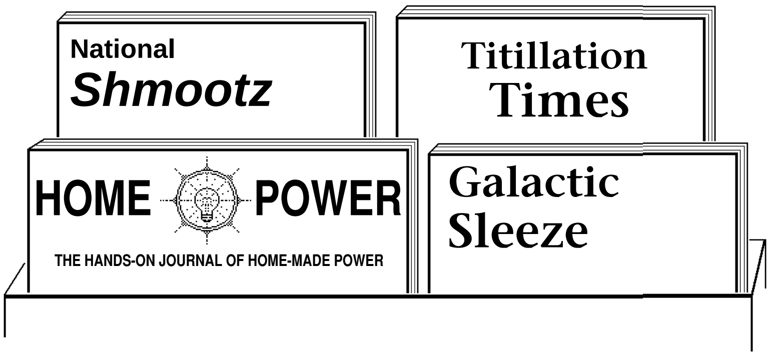
The next thing you have to do, Nick, is to sink an 8 ft ground rod. Then run bare copper wire from the metal frame of the rack to the ground rod. Regular size, depending on the Code in your state, will be either #6 or #4. KJS

NEWSSTAND HP

Dear Folks,

Thanks for entering my subscription just recently and sending my order for the issue #19 I had just missed.

"What you give your energy to grows stronger in 'your life' ". After reading # 19 cover to cover I found #18 in a local grocery store- all by itself- were they really selling HP or did this lone issue appear just for me?



In any case please forward back issues 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, (I can count) enclosed check for $26.

Can you tell me who built the VW EV on page 15 of #19 (Karman Ghia)?

Thanks for a great magazine. Keep up the GREAT work.

John Shuman, Everson, WA

People throughout the country should be seeing more of HOME POWER magazine on local newsstands and magazine racks. The beautiful Karman Ghia conversion was done by Scott Cornell, an individual competitor who made his own from available literature. We don't have access info on him, so, Scott , if you are a reader please answer up, you've got a fan club out here. Myself included. KJS

GRID UNLOCKED

Dear Home Power,

It has been a year and a half since the power company was told to disconnect us. Their meter reader was here twice looking for the meter. One of them looked all over the side of the house and then said out loud, "Where did it go?".

We are living a dream instead of just dreaming, thanks to your fine info. Thank you so much. Enclosed is $6.00 for more HOME POWER excitement.

P.S. We make about $275.00 per week gross and we can do it. Those who make much more need to be encouraged to jump in, the water's fine.

Feeling good, Bill Mielke, Ogdensburg, WI

Bill, it sure makes us feel good to get a letter like yours, we salute you! KJS

NORTHWEST NET?

I just recently moved out here to beautiful Washington state from New York City. Although I'm not able to live as far out in the country as I had originally hoped, I still am planning to buy some land(as far in the country as I could get) and build a house on it in the near(or not so near) future. Power will, of course, be provided via renewable energy sources. Toward that end, I would sincerely like to extend an invitation to all current & future home power producers/users in the Wash./Oregon/B.C. area to start a mutual correspondence. Maybe we can begin a very informal support network for all our mutual benefit? Or maybe, there is one already? Either way, I look forward to hearing from other home power producers/users soon.

Lastly, I wouldn't think of ending this letter without extending my compliments and gratitude to you and all the others who helped make HOME POWER a successful reality. Starting a business is tough enough without also trying to make it in the publishing world. I'm glad to see that you beat the odds in both cases. I know that I'm going to be better off for it and I just want to say thank you.

Sincerely, Richard Salita, Issaquah, WA

CODE ADVICE

Dear Home Power,

I just finished reading the HP #19 comments concerning NEC overkill. I agree that many of the NEC requirements seem to border on the absurd. These strange sounding, often times difficult to follow, requirements are the result of trying to make electrical systems "idiot proof". Well, we all know that idiots are much smarter than the designed system when it comes to circumventing the safety features. But if we use electricity, then we must deal with the CODE.

The key to putting up with the NEC as it concerns your AE system is your local state electrical inspector. Find out what the inspector is picky about when "buying off" jobs wired by local contractors. In my area it was... you guessed it, grounding. Discuss your proposed wiring with this electrical inspector. He may see that your way meets HIS interpretation of the NEC requirements. If so, great. If not, modify your plans on the spot if possible. This step alone will save you much grief, time and money. Then when that fateful inspection day arrives, hopefully your AE wiring will pass the first time!

Thanks for the "hands on", do it yourself publication. With the cost of living now days, the average single income backwoods(or desert rat in my case) person/family must get their hands dirty in order to make the AE dream a reality.

Charles and Vi Fountain, Organ, NM

You might get to know a local contractor, especially one that does AE systems and give him your support. The inspector will be much more likely to accept inputs from him than from an individual. KJS

FOSSIL FREE VIDEO

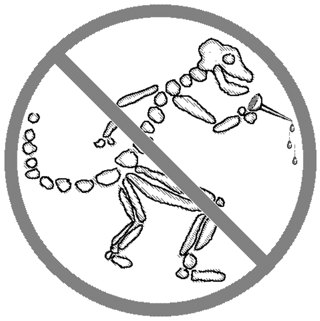
Dear Home Power readers,

Do you have ideas or examples of how we can live without fossil fuel that you would like to share with other people? I am making a video program about fossil-free living and am looking for people who would like to participate, either through being interviewed or by showing me their solar home, gridless electrical system, electric vehicle, etc.

I want to assemble a program that will make it abundantly clear that it is quite possible to live a technologically tuned-in life, without dependence on resources that are rapidly being depleted and are causing enormous environmental degradation. I think that a change in consciousness about these matters is critical for our survival, and that of most other life on earth.

I am an independent video producer, working either by myself or

with my wife. I have been interested in alternative energy and solar architecture for many years. I would hope to arrange a showing of the program to a national audience, as well as make it available to people on an individual basis.



So, if you are interested, contact me at the address below, and perhaps together we can help point the way towards a future that is free of our fossil fuel addiction.

Sincerely,

Kelly Hart, HARTWORKS, POB 777, Ashland, OR 97520 (503) 482-9585

POWER TO HELP

Dear Karen,

I spoke with you last Tuesday about a project our church and other community agencies have undertaken to assist a homeless family.

We recently learned of a family in our area who had lost everything in a house fire and had been living in their van for over three weeks. They had no income or money, but were sacrificing what little they had to insure their son remained in school. We have since found them a house, food, and clothing.

Some readers may well ask what the nearly ubiquitous problem of the homeless has to do with power production. I am convinced there are hundreds of vacant dwellings in this country which could house families in need if they had some modicum of electric power for common necessities such as water and lighting. Lighting is a relatively simple matter: DC lights, kerosene, etc., but water pumping seems to be a more difficult obstacle for most of us to overcome, and also the most likely candidate for thoughtfully implemented alternate power solutions.

I suggest that those of us who have an interest and belief in "Home Power" may be able to increase awareness of alternate energy while helping less fortunate members of our communities by seeking out these houses and APPLYING our principles. The benefits for all concerned should be obvious.

Our particular problem is that this house is remote and has no electric power. Since I spoke with you, we have decided to purchase a small gasoline generator to run a 1/2 hp, 220 VAC submersible pump for water, but would like to supplement it with a renewable input source for lighting or other light loads. We have access to a 5 KW, 48 volt inverter, and some batteries. We are also reasonably competent with mechanics and electronics. Our resources are very limited(who's aren't today?) and we do not anticipate being able to install any alternate power source in the near future. If any of you out there has anything you could donate we'd appreciate it. We'd also like to hear any ideas or suggestions.

Everything so far has been donated. We're trying to keep our involvement an anonymous as possible in the interest of the recipient's privacy and self-respect; however we will consider donations in exchange for publicity if these criteria can be met satisfactorily.

Please respond to:

Cowan Fellowship Church

Attn: Geoff Roehm/Power Project

609 E Cumberland, Cowan, TN 37318

APPROPRIATE TECHNOLOGY

Richard, Karen and Stan,

We're seeing a lot of interest lately in "Letters to Home Power" on the idea of burning fossil fuels for the production of electricity. Examples of this using cars and their batteries to run a sewing machine, woodstoves to produce steam to generate electricity, and small gen-sets. I'm a little disturbed by all of this.

Lest we forget, the major cause of the greenhouse effect is the production of CO_2 as a result of burning fossil fuels. Although we all loath what the mega-utilities stand for(big business, monopolies,price fixing, fat cats with cigars) the CO_2/Kwh/user of a utility is miniscule compared to what is spewed out by a Honda portable generator, a China Diesel, or an in-vehicle deep cycle battery set-up. If we all had gen-sets in our back yards, we would all have choked to death long ago!

Don't get me wrong. I am not advocating that we all flock to our local mega-bucks power company. But the above mentioned ideas for producing electricity do not represent appropriate technology, nor is it what renewable energy is all about. I do realize that any way we generate electricity, or any power for that matter, involves some compromises. I certainly don't know all the right answers, but I do know the wrong ones when I see them.

By the way, I am not pure by any means. I heat with wood and drive a diesel pick-up. But I'd never consider using either to generate my electricity.

I hope that no one takes all of this as a personal affront. This letter is not meant to admonish anyone, but only to stir some thought and possibly generate some dialogue on the subject.

Mick Sagrillo, Forestville, WI

Well, Mick, your point is well taken. However, one point you missed was that Denise Peterson, in Letters, HP#19, P58, did not have her vehicle running outside while she used her sewing machine, she used the power that was there from her necessary commuting. KJS

"Ya run what ya brung" We all make compromises in everything we do. Energy is no exception. Karen and I use a back-up gas fired generator, a wood stove, and a gas powered truck. We are all in a transistion period between combustion based energy technologies and to something better. Something better means the use of renewable energy sources like sun, wind, and water whenever and wherever possible. And when these alternative are not possilbe, we all use what is on hand. And if it's a truck that commutes daily, then that's the way it is.

In this transistion period we need to use combustive technologies as little as possible. Every PV panel that sees sunshine is a step forward. Every wind machine and every hydro working brings our freedom from combustion closer. RAP

TYPEWRITERS

Dear Home Power,

I have a stand alone wind system (1800 watt, 32V Jacobs) and a Trace inverter. I have had problems with my electronic typewriter, a Smith Corona SL600. It malfunctions in various ways, missing letters, double spaces, etc.

It checks out fine at the repair shop and I have pretty much determined it's the inverter's fault. Anyone else have this problem? The Trace works great otherwise.

Thanks, Tom Simko, Inkom, OH

TURNTABLES

Dear HP,

Thank you for getting out all the Alternative Energy Information to us. Your magazine is indeed a blessing.

My turntable-- an old Technics-- does not like the power I feed from the Trace at all. It runs fine, but it gives off an awful lot of noise. Is there any way to help this turntable out? Are there any 12 VDC units out there? Any help would be appreciated.

Chip Usal, Mt. View,UT

Many electronic devices have problems digesting the modified sine wave output of inverters. Common problems include buzzing on audio systems, black horizonal noise lines on video systems, and weird glitches like the typewriter on the previous page. There are three levels of potential fixes:

1. Install a 120 vac line filter. Try Radio Shack #15-11 at $10.95, it handles up to two amps at 120 vac. Try Radio Shack # 61-2780 at $29.95, it handles up to 15 amps at 120 vac.

2. Install a ferro-resonant power conditioner. These power supplies use saturable reactions to provide voltage regulation and isolation from the gird in conventional 120 vac systems. While they are designed to filter sinusoidal power, they will function well on modified sine waves. We have tried the units made by SOLA and they function well. They are avialable from 100 to 1000 watts and are not very efficient on inverters. So size the SOLA to meet only the needs of the offending electronics. Power conditioners are phantom loads, so disconnect them when not it use. They are also expensive about $1 to $2 per watt.

3. Add additional capacitive filtration to the secondary side of the power supply. Find the secondary of the unit's power transformer and add a between 50,000 and 500,000 µf. electrolytic capacitor after the regulator. This shuts up most offenders, but is a job for a techie who knows what to do. RAP

ANTENNA ARTICLES ABOUND

Greetings,

Congratulations for a very readable, informative, and fun magazine. I have a few comments:

In HP#15 the 'Minto Wheel' is mentioned. A little more info can be found in 'Popular Science' for March 1976, P 79.

In HP#17, some folks were striving for reasonable AM reception. 'Audio' magazine for January 1982 has a pair of articles on antennas. Loops for AM and some interesting rhombics for FM are discussed.

Another AM antenna that folks with a lot of real estate and some ability to deal with electronics may be interested in is the Beverage. Named for it's inventor, the Beverage is a long (2,000 ft. or more) wire or pair of wires that head in the direction of interest. The antenna 'collects' the incoming radio wave while rejecting signals - including man-made and natural noise - from other directions. 'QST' magazine for June 1977, P 35, has a discussion of Beverage antennas including one fashioned from an electric fence. The 'ARRL Antenna Book', 1988 edition, has a good section on Beverage antennas. The references given in these publications are exhaustive.

Those installing any long wire antenna should ensure that it is high enough or otherwise protected(as along a fence) so that animals, including people, do not become entangled. Also, during and after installation, the antenna should have a DC path to ground. Several hundred feet of wire can collect an impressive static charge.

I also enjoyed the battery comparison.

HP#18 has an excellent glossary. One nit to pick, though. RMS is not a 'time averaged' function. For example, the average value of a sine wave is zero but the RMS value is positive.

The RMS value of a given voltage or current that would produce the same heating in a resistor as the given waveform. RMS doesn't apply to power as power is considered positive, although it can flow in any direction.

I agree with Wiles (HP#18 P57,58). Publishing the POWER output of PV arrays under STANDARD conditions would be extremely informative.

Here is my vote for more information on Zellers (HP#18, P57) 200 A welder.

Enclosed please find $4.00 for back issues #14 and#16. I would pay more for HP printed on recycled paper. Thanks very much!

Jerry McDonald, Salt Lake City, UT

Thank you, Jerry, we stand corrected on RMS. KJS

BATTERIES

Dear Home Power,

My system is comprised of 19, 35 Watt panels so far. For this size of system; 1. What is the best battery available? 2. What is the most popular battery?

Chris Peterson, Aurora, UT

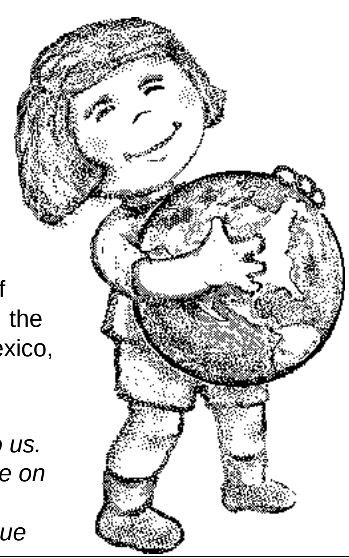
The answers are; 1. Pocket-plate nickel cadmium batteries 2. You really did not give us enough information as every system is as unique as it's owner. KJS

AE CHILD

Hello Karen and Richard,

I love your magazine, I have a copy of all of them. My son, now six, has always lived on photovoltaic electricity, and I hope he, with many of your readers' children, will be a generation that has always lived on alternative energy. I think that would make some interesting research (The Children on Alternative Energy).

Our son has habits and insights that I have only recently acquired. As he grows up I am sure he will take that insight, and apply it to what he is doing.



Next summer we are building a PV powered go-cart. I see a great future in him, as I am sure many of your readers see in their children.

Your magazine makes a great text book, and I hope for a little more space devoted to them. If you need a writer I would love the job. Always Sunny in New Mexico, Kurt Andersen, Ramah, NM

Wonderful idea, Kurt, do it! Write to/about/for children and send it to us. We want to hear from other people on this subject. Refer to Writing for Home Power Magazine in this issue

Writing for Home Power Magazine

Home Power specializes in hands-on, practical information about small-scale renewable energy production and use. We try to present technical material in an easy to understand and easy to use format. If you want to contribute info to Home Power, then here's how it is done…

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Please include all the details! Be specific! Write from your direct experience- Home Power is hands-on! We like our articles to be detailed enough so that a reader can actually apply the information. Please include full access data for equipment mentioned in your article. Home Power readers are doers. They want access data for the products you mention in your article.

Article Style and Length

Home Power articles can be between 500 and 10,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short and to the point. We like the generous use of **Sub-Headings** to organize the information. We highly recommend writing from within an *outline*. Check out articles printed in Home Power. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

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We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over two times more articles submitted than we can print. The most useful, specific and organized get printed first.

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We can work from any photographic print. The best results happen if we have a black & white print rather than color. We can work from a negative if necessary.

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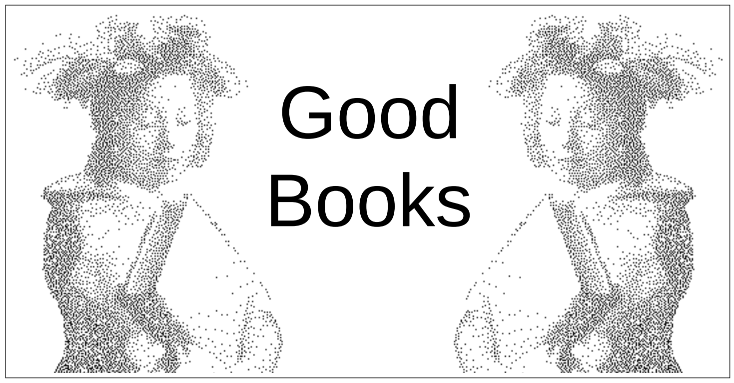
RP



Wiring 12 Volts for Ample Power

written by David Smead and Ruth Ishihara

reviewed by the Wiz

This book is a basic introduction to electrical energy with a marine slant. It covers the history, basic theory, use, measurement of electricity, as well as the equipment, tools and practices necessary to create, store, and use this type of energy.

Although no part is covered in great detail, this is still a very good entry level book. Even kids could understand this one. This book would be a nice introductory resource for those just venturing into the home power field. Since many topics are lightly covered, those who already have their systems up and running might find some useful information here too.

Available from Ample Power Co., 1150 NW 52nd St, Seattle, WA 98107, 800-541-7789, for $18.50 ppd.

Ozonal Notes

I sometimes miss climbing on folks' homes and installing a fleet of PVs. There is something about leaving the homestead with everyone all smiles and electrified. But now I get shocked via osmosis. Karen and I are now officially out of the Biz. Home Power, Inc. has become a reality and we now push around information instead of electrons. And we're movin' on…

OOZIE

With regard to the OOZIE backwoods electric vehicle project: We are surprised to hear how many of you share the same concept. Don Harris is into the wheel motors and will be making the prototypes on is hydro-powered lathes. We are starting a design newsletter around the project (as if we didn't do enough publishing) and will circulate it to all interested. Our design objective is a low speed, four-wheel drive solar electric buckboard. 30 mph tops with a 50 mile range. Payload around 1,000 pounds with rough terrain capability. If you want in on OOZIE, write Home Power and say you want to get the OOZIE Design Newsletter.

Since the hour is late and this issue full, only this space remains for Karen and I to say thanks for the love and support flowing from all home powered folks everywhere. Have a wonderul holiday season and keep putting up those panels, windmachines and hydros. From where we sit, it is making a difference not only in fact, but more importantly in national attitude. My compliments, you are dong well.

Richard & Karen

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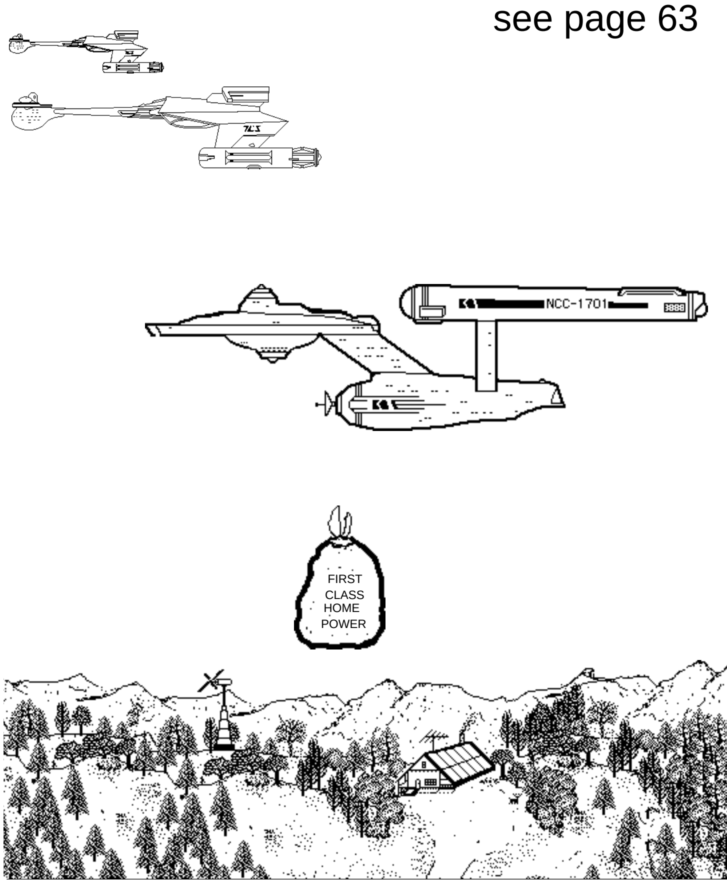
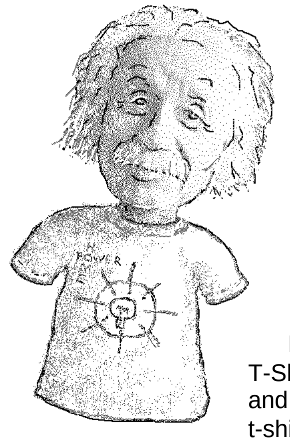
FIRST CLASS HOME POWER -

see page 63



Put your favorite head into a



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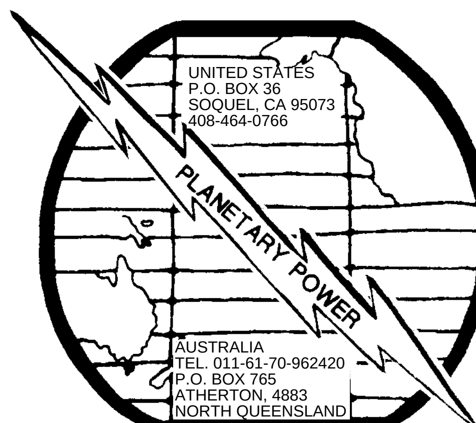
Small Print: Sure HP makes a buck or two on this deal. Ya want to know where the money goes, well, you are holding it in your hand at this very moment. Thanks, the HP Crew.



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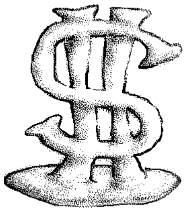

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Thomas Lipton - 1870.

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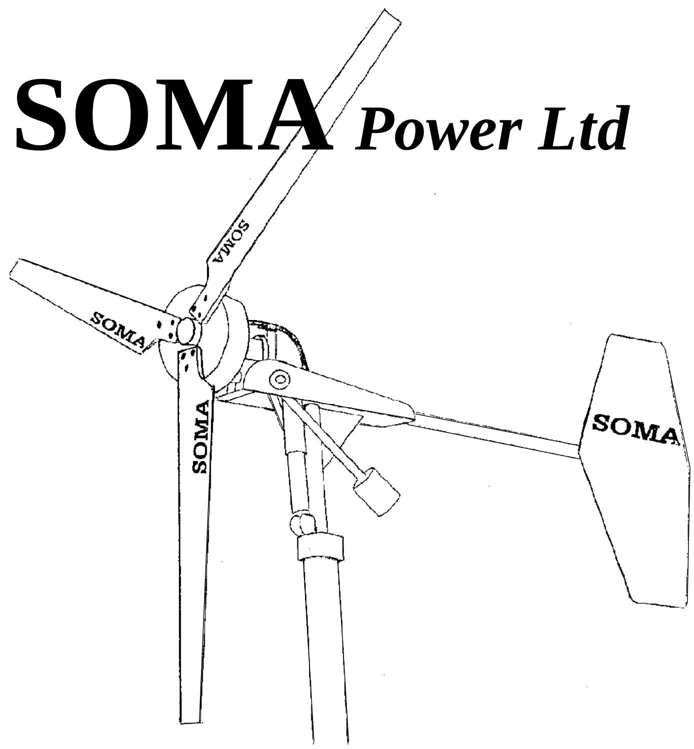

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